Department of the Army
Federal Emergency Management Agency
Chemical Stockpile Emergency Preparedness Program

January 27, 1999

MEMORANDUM FOR: See Distribution

SUBJECT: The Chemical Stockpile Emergency Preparedness Program Off-Post Monitoring Integrated Process Team Report

The enclosed Chemical Stockpile Emergency Preparedness Program Off-Post Monitoring Integrated Process Team Report has been reviewed and approved. This report is to be used as guidance and should be distributed to all appropriate personnel within the CSEP Program.

The document provides national level guidance, information, and examples to help Depot, State and County CSEPP staff develop and implement plans and protocols for off-post monitoring in the event of a CSEPP chemical accident/incident (CAI). The report provides a list of issues, equipment, and recommendations, which jurisdictions may consider in planning for response, and recovery activities associated with a CAI.

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Attachment

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CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM

LOCAL STATE FEDERAL

THE CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM (CSEPP) OFF-POST MONITORING INTEGRATED PRODUCT TEAM (IPT) REPORT

December 1998

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Executive Summary

Background:

Public Law 99-145 (November 1985) directs the Department of Defense to destroy the stockpile of chemical warfare weapons stored at eight U.S. Army installations within the continental United States while providing maximum protection to the general public, the environment, and the workers involved in their destruction. The Chemical Stockpile Emergency Preparedness Program (CSEPP) was established in 1988 to enhance the emergency preparedness and response capabilities in and around these locations in case of a chemical warfare agent accident/incident (CAI). The CSEP Program encompasses all aspects of chemical stockpile emergency preparedness.

Off-post monitoring is a critical aspect of CSEPP because, in the event of a chemical warfare agent (CWA) release, workers and public safety will most likely depend on the accurate and efficient application of detection and prediction capabilities. The complexities of this issue include among other things:

– Different sites have different stockpiles, demographics, and local laws, resources and regulations.

– Response and recovery phases of a CAI have very different off-post monitoring requirements.

– Equipment capability, availability, reliability, and usability vary.

Method:

In February 1997, the CSEP Program established an Integrated Product Team (IPT) to prepare recommended guidance to establish plans for off-post monitoring at each stockpile site. The members of this team represent the spectrum of CSEPP participants at the federal, state, and county levels, in technical, management, and support roles. We reviewed existing documents, consulted technical experts, used our within-team experiences, and incorporated comments received from the CSEPP community to develop the following proposed guidance document for off-post monitoring. A monitoring case study, a list of available equipment, and several other resource appendices are included in the document.

The foundation of the document is identification of the six critical decisions that must be addressed by off-post authorities. Assumptions and strategies contained herein should be reviewed at each site for applicability to aid in developing the monitoring plan. The six critical decisions are:

– Determine the existence of contamination.

– Determine the need for decontamination.

– Determine appropriate work rules (i.e., level of protective equipment required).

– Determine when to egress from collective protection and/or sheltering-in-place enclosures.

– Determine when the off-post population can return to the evacuated area.

– Decisions related to special monitoring cases.

Conclusions:

After review and analysis of considerable material, we conclude that the most helpful approach is to identify common factors and provide information of a non-directive nature as guidance. The only effective approach to monitoring is the one that is accomplished at the CSEPP site. We conclude the following:

– **Each site needs to develop a coordinated off-post monitoring plan**. It is essential that at each storage location a coordinated off-post monitoring plan be developed that addresses actions to be taken in the event a CAI occurs. Coordination and applicable agreements must include the Army Chemical Activities, the counties, the state, and federal agencies. The agreement should define the expected equipment, procedures, and coordination. It should separate response requirements from recovery requirements.

– **Monitoring resources will always be limited**. Therefore, emergency managers should limit monitoring efforts to support critical decisions whenever possible. We believe that planning and developing a coordinated off-post monitoring agreement can be aided by use of the common issues, assumptions, critical decisions, corresponding strategies and recommendations, and appendices identified in this report. These critical off-post decisions should be tailored and amended to more directly apply to each specific site.

– **Exercise monitoring methodology**. Test the monitoring plan that is developed. Become familiar with the methods and equipment that are available (i.e., where should equipment be located, how should it be maintained, calibrated, used, and disposed of). Understand the relationship between, and need for, models and actual monitoring.

We have endeavored to make this guidance specific enough to be useful while being general enough to apply to each site. We accept the fact that the guidance may not satisfy all readers. However, we believe it is sound and represents the collective best professional judgment of the team members.

REPORT

OF THE

CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM OFF-POST MONITORING INTEGRATED PRODUCT TEAM

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REPORT

OF THE

CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM OFF-POST MONITORING INTEGRATED PRODUCT TEAM

1 June, 1998

PREAMBLE

Chemical weapons stockpiles evoke high levels of public concern. The members of the Off-Post Monitoring Integrated Product Team (IPT) met between February 1997 and April 1998 to develop guidance, not policy, regarding off-post monitoring related to chemical accident/incident (CAI) stockpile emergencies. We accept the possibility that this guidance may not satisfy all readers. However, we believe the guidance reflects our collective best professional judgments. Inevitably, we could not report all of our discussions. We welcome inquiries from readers seeking clarification of the guidance presented herein.

INTRODUCTION

PURPOSE

This document provides national level guidance to help develop and implement plans and protocols for off-post monitoring of a Chemical Stockpile Emergency Preparedness Program (CSEPP) CAI which threatens or impacts an off-post community. Site-specific concerns, concepts, and requirements need to be part of the local plans.

SCOPE

Local, state, and federal agencies should use this guidance to develop the necessary site-specific off-post monitoring plans and protocols at each of the eight stockpile locations. This report provides a list of issues, equipment, and ideas which jurisdictions may consider in planning for response, re-entry, and recovery activities associated with a CAI. Local authorities are expected to use other available resources in developing their plan. An example of how this guidance could be developed into a CSEPP recovery/sampling plan is shown in the Case Study at Appendix A. The following major definitions apply throughout this document. A glossary of acronyms is found at Appendix B.

- **CSEPP: Chemical Stockpile Emergency Preparedness Program.** The program established to enhance the existing emergency preparedness and response capabilities of the communities near chemical stockpile storage sites and the eight U.S. Army installations where the stockpile is stored.

- **IPT: Integrated Product Team.** A recommending body composed of representatives of all appropriate functional disciplines working together to build successful programs by recommending strategies, policies, and plans.

- **CWA: Chemical Warfare Agent.** A chemical substance that is intended for use in military operations to kill, seriously injure, or incapacitate a person through its physiological effects.[1] Excluded from consideration are riot agents, chemical herbicides, and smoke- and flame-producing agents. CWAs fall into the following categories:

    1) Nerve agents: VX and GB (Sarin)

    2) Blister agents: Mustard (HD & HT)

- **CAI: Chemical Accident/Incident.** An accident or incident involving the stockpile of CWA at any one of the eight U.S. Army installations involved in the CSEP Program.

- **PPE: Personal Protective Equipment.** Protective clothing and respiratory protection to enable responders to conduct activities while protecting themselves from possible exposure. Equipment should protect skin, eyes and the respiratory tract.

BACKGROUND

In November 1985 the U.S. Congress passed Public Law 99-145 directing the U.S. Department of Defense to destroy the U.S. stockpile of unitary CWA while providing the maximum protection to the environment, the general public, and the personnel involved in the destruction. The Chemical Stockpile Emergency Preparedness Program (CSEPP) was subsequently established to enhance the existing emergency preparedness and response capabilities of the communities near chemical stockpile storage sites and the eight U.S. Army installations where the stockpile is stored.

The U.S. Army and the Federal Emergency Management Agency (FEMA) entered into a Memorandum of Understanding in August 1988 which recognizes the unique technical capabilities of both agencies by outlining their specific roles and responsibilities in developing the CSEP Program. Since then, CSEPP evolved into a cooperative effort that relies on the combined capabilities of the U.S. Army, FEMA, and State and Local governments to determine program policy and guidance. FEMA and the Army signed an updated Memorandum of Understanding in October 1997.

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[1] Toxicity information included in Appendix H.

CSEPP Policy Paper Number 2, issued in October 1993, establishes policy on environmental monitoring and sampling in the event CWAs are released to the environment. However, as monitoring technology improved (i.e., changing from gross-level monitors and laboratory analysis to real-time low-level monitors with alarm capability) more and more questions arose about what equipment to use, when to use it, how it is to be used, and what information it provides.

Members of the monitoring community from various Army installations met in May 1996 to determine the requirements for off-post monitoring. During the course of the meetings they decided that membership of a team charged with determining the off-post monitoring requirements must include representatives from FEMA and state and local governments because the majority of the team's decisions would have a direct impact on the off-post communities surrounding the eight storage sites. An expanded IPT consisting of some original members plus representatives from local government emergency preparedness, State health, labor, and environmental departments and FEMA met in February 1997. During the course of this and other IPT meetings, non-IPT members were consulted to provide ideas about monitoring, equipment, and procedures.

For example, a case study (reference Appendix A) was developed by the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM), based on the CSEPP exercise at the Pine Bluff Arsenal, Arkansas, in February 1997. We felt that the scenario used in this exercise would provide a basis for developing a comprehensive recovery sampling plan which, for the most part, could be used by all storage sites to develop their local plans.

At the initial meeting, we established decision-making rules that identified legitimate approaches to monitoring planning, and recognized that it would be more acceptable to report on multiple approaches instead of narrowing our recommendations to only one approach. This concept should encourage the users of this document to look at several means to develop their monitoring plans.

This document addresses the unique aspects required of CSEPP monitoring plans and protocols. We are cognizant of historical and concurrent activities undertaken by other groups which deal with monitoring. Further, we have made a legitimate effort to review and use, where appropriate, information and concepts proposed in these other arenas (e.g., HAZMAT (Hazardous Materials), Gulf War syndrome, terrorism response, nuclear accidents or incidents, existing military doctrine, and information provided by equipment vendors). Readers should understand that there may be differences between a CSEPP CAI and these other activities, and therefore, plans and protocols may not necessarily be transferable. However, we agreed that all recommendations should meet the following four equally important criteria. The order of listing does not represent a priority.

- **Personal criteria.** The main question each of us asked is "Do I or would I trust this concept myself?" To make a monitoring plan work, those who develop it must believe in the concepts and procedures.

- **Political criteria.** We asked, "Is this guidance publicly explainable, understandable, and supportable?" These criteria explicitly address public perception. If the plan gains a favorable public image, then the actions taken by the various governments will be accepted even though a period of hardship may be encountered. Some monitoring efforts may be undertaken for the specific purpose of instilling confidence in the minds of the public.

- **Technical criteria (science).** We asked, "Is there a solid technical basis for the guidance?" We knew that this guidance needed to "work" in the sense that it could be successfully implemented from a technical point of view. We decided to look at all aspects of monitoring, particularly equipment. We didn't limit ourselves to just the equipment in the Army inventory, but looked at all services, commercial vendors, and other government agencies, as well as other countries. The equipment list (Appendix C) reflects this far-ranging investigation.

- **Fiscal criteria.** We asked, "Are the costs of recommendations reasonable?" Cost of the monitoring program is a factor in making the various decisions relating to the off-post monitoring program. Equipment costs, especially commercial-off-the-shelf (COTS) purchases and other associated life-cycle costs, will have a critical impact on various governmental fiscal and operational plans. We looked at end results in relation to equipment costs and concluded that results are paramount.

ISSUES

When we began our discussions as an IPT, we discovered that despite our differences in perspective, we were concerned about a common set of issues. For example, we all recognize that off-post monitoring in a real CSEPP situation will not be the same as monitoring in a non-emergency situation. We recognize that CWA accidents/incidents involving spills, explosions, and fires present slightly different challenges for off-post monitoring. We recognize the need to share our common understandings in this guidance. We believe the following nine issue areas need discussion because of their impact on developing local monitoring plans:

CHEMICAL WARFARE AGENT CHARACTERISTICS

The expected characteristics of a chemical agent plume can make potential monitoring difficult. The chemical plume once it crosses the depot boundary, regardless of agent type, release mechanism, and weather conditions, will be composed almost entirely of vapors.[2] The remainder of the plume would consist of small particles (aerosols) that could deposit on surfaces. As a result, the plume is expected to drift and dissipate with the wind, and so could arrive and depart at any location within a few minutes or few hours, depending on the accident release duration, distance from source, and wind speed and direction. Any CWA in the air, therefore, could be relatively short-lived.

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[2] Paddock, R.A., et al, 1994. Potential for Surface Contamination by Deposition of Chemical Agent Following an Accidental Release at an Army Storage Depot. Argonne National Laboratory, Argonne, IL.

It must be recognized in planning for such an accident that the chemical agents have very different physical and chemical properties. The nerve agent GB is relatively volatile, evaporating at about the same rate as water.[3] This means that the plume will likely consist entirely of chemical vapors, regardless of release type and weather conditions. VX and HD are far less volatile than GB, i.e., more persistent. VX evaporates at about the same rate as motor oil, with the evaporation of HD in between that of GB and VX[4]. This means that the plume could consist of small particles (aerosols) in addition to the chemical vapors. The ratio of aerosols/vapors will increase for certain release types. Accidents involving fires with explosively configured munitions will have the highest ratio of aerosols, while all other CAIs would produce an off-post plume composed virtually entirely of vapors. Note, however, that even if aerosols are embedded within the plume, the greatest threat for the civilian community will be from the vapors.

CHEMICAL WARFARE AGENT DISPERSION

Projections of a chemical plume (i.e., hazard analysis) would be provided through an atmospheric dispersion model known as D2PC.[5] This model simulation is intended as a basis for formulating protective action strategies by identifying those populations who are potentially at risk of CWA exposure. It is specifically designed to provide a conservative estimate of the consequences of the release, i.e., it should overestimate the actual concentration of CWA at a given location and generate a larger protection action wedge.

One of the main reasons the D2PC model provides a conservative estimate of agent concentration in most real situations is its assumption that the chemical plume will be released and travel over open (non-forested), flat terrain. This assumption is based on the open-air testing of chemical agent munitions during the 1950's and 1960's conducted at Dugway Proving Ground (UT) and Edgewood Arsenal (MD). The testing areas at both of these sites consist of open, cleared land. Model predictions have been compared to actual plume travel monitored in the test areas and model predictions are very close to what was actually observed during the test CWA releases. Testing has also included weapons functioning under accident conditions such as fire, mechanical impact, and explosion. The D2PC model has the ability to predict agent travel under these conditions, providing that terrain is flat, vegetation low growing, and weather factors such as wind direction, wind speed and temperature are fairly constant. We know that where these conditions do not exist, the effect on agent travel is a reduction of the overall risk area

CSEPP sites have variable terrain elevations, forests, and other topographical features that tend to cause more atmospheric turbulence. This will cause more dilution of agent vapor than open flat terrain and will, as a result, always tend to reduce the concentrations within a chemical plume. The D2PC calculated concentration (based upon

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[3] Potential Military Chemical/Biological Agents and Compounds, Army Field Manual 3-9, December 1990.

[4] ibid.

[5] Whitacre, C. Glenvil, et al, Personal Computer Program for Chemical Hazard Prediction (D2PC), CRDEC-TR-87021, January 1987.

open flat terrain and constant weather will generally exceed the actual concentration by a factor of two to ten[6] times if the effects of terrain, vegetation, and weather could be accounted for.

DISPERSION MODELS VERSUS SAMPLING

Computerized dispersion models, such as D2PC, are used to predict vapor concentrations and dosage at various locations. The models take weather data such as wind speed, wind direction, temperature, time of day, stability category, and other factors, such as number and type of munitions and type of release (source term), to calculate the CWA dispersion when a CAI occurs. At the beginning of a CAI, very little information is known about the actual source term. To compensate for this absence of actual information, the Army and off-post authorities use “maximum credible event (MCE),” to estimate the source term. The dispersion of CWA is calculated, and a prediction which tends to overestimate the size of the actual downwind hazard is made. To provide an additional margin of safety for the public, a wedge area is drawn downwind from the CAI site. This area surrounds, and is wider than, the downwind hazardous area predicted by the model. This protective wedge is used by planners to develop protective action strategies.

A model exists which can predict liquid deposition. This model is located at Studies and Analysis Office at Aberdeen Proving Ground, MD. This model can predict levels of agent hazards and the probable location as a factor of the type of release, quantity of agent involved, and weather. If required, a hazard analyst familiar with the factors affecting deposition of CWA’s can provide a qualitative prediction of a deposition.

A frequently asked question is, "Why shouldn’t we use CWA detectors to supplement or confirm initial hazard predictions used for shelter-in-place or evacuation decisions?" The answer is since the off-post response to a CAI must be carried out very quickly, a greater portion of the population should be able to react safely to the computer predictions. This "broad brush" hazard prediction approach used with the D2PC model should provide emergency managers with more useful information in making protective-action decisions. CWA detectors cannot be used to reliably predict dispersion or deposition over a wide area; however, CWA detectors can provide real-time exposure data measurements, at a specific point in time during recovery.

EQUIPMENT SENSITIVITY LIMITS

All CWA detection processes or equipment have a minimum detection capability, sometimes called the Limit of Quantification (LOQ). This means, for all methods of sampling or detection, that below a certain level specific to a piece of equipment or process, CWA may be present but not detected. The more sensitive processes can reliably quantify CWA in air, at the part per trillion level.[7] Less sensitive detectors will detect only

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6 Hanna, Briggs, Hosker, Handbook on Atmospheric Diffusion, p 30, Technical Information Center U.S. Department of Energy, 1982

[7] PPM (Parts per Million)/PPB (Parts per Billion)/PPT (Parts per Trillion) Conversion (volume)

as low as parts per thousand. The LOQ for each detector varies with the specific CWA and requires trained operators. Additionally, equipment sensitivity and reliability are directly related to calibration and maintenance programs. Detection equipment performance is listed in Appendix C.

MONITORING IN AIR VERSUS OTHER MEDIA

An unstated condition of routine air monitoring is that samples are taken from isolated volumes of air or in direct proximity to suspect materials (either inside structures, from inside plastic bags when a suspect item is small enough, or directly above visible drops suspected to be CWA). The assumption made under these circumstances is that the CWA concentration found is representative of the concentration throughout the structure or container. Air samples may be taken from open air. Unknowns may include wind direction, time after release, distance from CWA source, size of CWA source, and a host of other such variables. However, applying the results of these samples to represent an area is extremely questionable.

If present in sufficient quantity, CWA may be detectable in media, such as soil, water, or vegetation. Samples of these media must be taken to a certified CWA laboratory where very low levels of CWA can be detected. Obtaining and staffing a laboratory facility capable of doing this type of work requires preplanning. A list of certified U.S. laboratories is at Appendix D. Water, as a medium in which CWA may be detected, presents a number of challenges. Unlike air, CWA can be detected in water only in relatively high concentrations. Water will tend to chemically react and/or hydrolyze CWA, especially if the water has a high or low pH. Fast-moving streams and rivers will dilute deposited CWA aerosols within a few minutes. Bodies of water close to the CAI site (post accident) will be more likely to have detectable concentrations than bodies of water further away.

When media are to be sampled, trained personnel must take samples in a systematic manner to try to determine whether an area or object is contaminated. Air samples are relatively simple to take, and a number of systems are available which make quantitative determinations of CWA concentration possible. However, the analysis of air samples to make quantitative determinations is complex. Some detectors provide actual concentrations while others simply indicate whether CWA is present at a level greater than or equal to a concentration value for the detector. There are no instruments which can reliably determine CWA levels in media other than air which do not require sophisticated laboratories and chemists to support. To ensure that statistically valid data are generated, Quality Assurance/Quality Control plans must be implemented in sample collection, custody protocols, and laboratory analysis.

For Compound	1 PPM equals:	1 PPB equals:	1 PPT equals:
HD (Sulfur Mustard)	6.51 mg/M^3	6.51E-03 mg/M^3	6.51E-06 mg/M^3
GB (Sarin)	5.73 mg/M^3	5.73E-03 mg/M^3	5.73E-06 mg/M^3
VX	10.94 mg/M^3	1.09E-02 mg/M^3	1.09E-05 mg/M^3

QUANTITATIVE VERSUS QUALITATIVE

Monitoring for CWA is one method of generating data which, when processed, can serve as an aid to people needing to make decisions on different courses of action during a CAI. Certain activities such as decontamination or selection of PPE must start or stop at a given CWA concentration. Several types of samples may be collected, depending on the requirements. CWAs are most commonly detected or sampled by detectors which can determine concentration in air. Off-post authorities may find that monitoring results are not definitive. Decisions will still be required, so off-post authorities will need to develop protocols which consider other relevant information. These protocols should include relevant data such as weather conditions, precipitation, distance from the CWA source, elapsed time after the event, terrain, vegetation, temperature, total amount of CWA released, and type of release. The protocols will use qualitative decision aids to assist off-post authorities where quantitative data are unavailable.

SAMPLING LOGISTICS

In a CAI, the CWA is not spread in a random manner but in a weighted distribution and will require a more complex sampling plan. A very large CAI might have suspect areas totaling several million square meters, rather than several hundred thousand. Properly conceived plans and procedures will, at best, provide only reasonable assurance of safety. Significant problems will exist in getting personnel and equipment to the affected areas if no plan has been drafted and no arrangements agreed to in memoranda of understanding/agreement. Preplanning will allow monitoring operations to run more smoothly in a CAI. The level of confidence at which we can ascertain that CWA concentrations do not exceed levels is highly dependent on the number of samples collected. Generally, the greater the number of samples collected, the higher the confidence level that can be assigned any one conclusion. A drawback to increased sampling activity is the time required to process the increased samples. Hence, the greater the level of confidence that is desired, the more time and energy that must be expended.

BACKGROUND INFORMATION:

Baseline chemical information is not necessary to monitor the presence of CWAs during a CAI emergency. However, background data/information should be compiled in order to create a historical perspective on each chemical activity and depot. This information may help explain any anomalies encountered during sampling operations. The data should include, but not be limited to, existing analytical data obtained from federal/state/local permitting activities, as well as any information on activities that have previously been co-located on the depot. A source of historical information available may include data available through each states regulatory programs in the areas of water, hazardous waste as well as the various agricultural and fish and wildlife programs.

Areas adjoining the depot should be surveyed, to include information on any active or historical industrial/manufacturing activities that have been present, as well as agricultural practices. Agricultural should include crops grown, chemicals routinely used or stored plus the types of live stock raised.

Other important information includes geographical data such as terrain features, water bodies (static and free flowing), soil types, vegetation types including forested areas and etc. Where possible the data gathered should include latitude and longitude identification, elevations and stream flow/direction data. All information should be compiled in a GIS database, if possible. This subject is discussed in Appendix A.

DEVELOPING PLANS: The IPT realized that off-post monitoring plans will be developed and implemented as part of the overall CSEPP Planning Process. The flow chart below illustrates this process.

Developing Plans

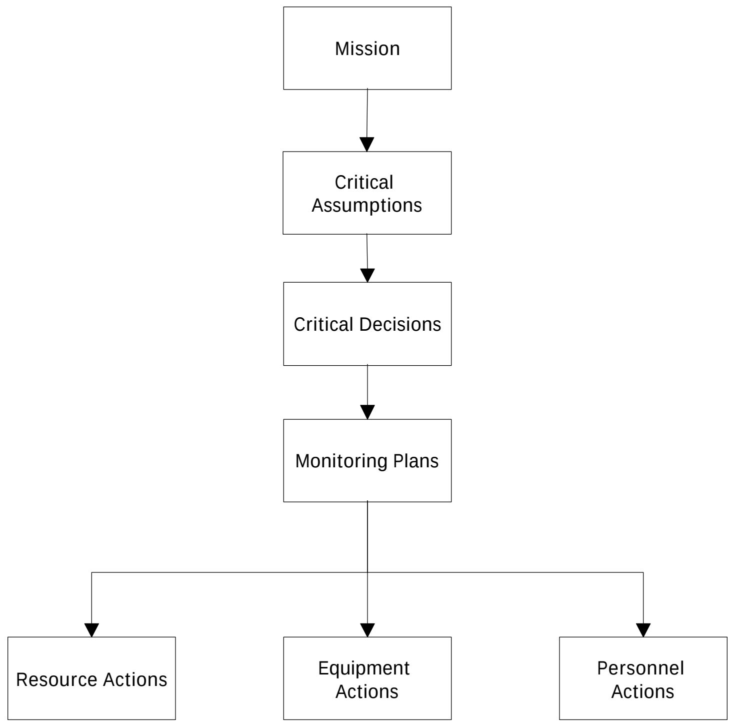

Figure 1

CRITICAL ASSUMPTIONS

We found it necessary to establish several critical assumptions to consistently address the issues involved with off-post monitoring. These assumptions are the foundation that led to the development of this guidance. The six critical assumptions are defined as follows:

1. MONITORING IS A TOOL FOR DECISION-MAKING.

Outwardly, this assumption seems obvious. It does, however, emphasize that monitoring resources are limited and their use must be prioritized. The question "What decision will I be able to make after I collect and interpret this information?" should always be asked before the monitoring resources are expended. Monitoring should be undertaken only if the results provide data that will have a direct impact on supporting a particular decision or course of action. Monitoring that does not directly support a required decision or course of action should only be considered only as a low priority, if at all.

2. INITIAL RESPONSE SHELTER-IN-PLACE /EVACUATION STRATEGIES AND RECOMMENDATIONS SHOULD BE DRIVEN BY PREPLANNING AND MODELS, NOT BY MONITORING.

The first emphasis in a CWA CAI must be on preventing/reducing public exposure to hazardous concentrations of CWAs. Establishing conservatively bounded protective-action zones and starting evacuation, collective protection, and shelter-in-place activities are time-critical in preventing/reducing public exposure. To provide maximum protection for the public, the implementation of preplanned emergency response activities should begin immediately upon notification of a CWA event rather than delaying action until monitoring is accomplished.

Numerous national-level regulatory and guidance documents are available to assist in the plan development. A partial list of documents applicable to CSEPP is found at Appendices E and F. State and local documents must also be consulted, where available.

3. MONITORING WILL NOT DETERMINE A ZERO LEVEL OF CWA.

It is critical to recognize that, even with the advent of extremely sensitive monitors, limitations exist with all sampling equipment and methods. Monitoring is only as effective as the equipment used and the personnel using the equipment. Capabilities and limitations of the monitoring equipment must be considered prior to and during monitoring. Although an absolute determination on the absence of CWA cannot be made, correct and careful application of equipment and methods will provide data for the development of a public health risk assessment of the item or area under evaluation.

Monitoring provides data about the presence and concentration levels of CWA. This information is evaluated for severity of exposure to CWA. Monitoring does not directly provide levels of risk. Risk is the probability or likelihood of injury or harm from exposure to a CWA. Risk assessment is a process of evaluating the level of risk by looking at the following:

– The characteristics and nature of the CWA to cause harm.

– The relationship between magnitude of exposure and the probability of the occurrence of harm (dose-response relationship).

– An exposure assessment - extent of exposure to CWA.

– The risk tolerance and perception of harm.

4. MONITORING TECHNOLOGY CANNOT ALWAYS DETERMINE CWA PLUME TRAVEL.

Factors such as wind shifts, topography, vegetation, and precipitation will affect the plume movement. The quantifiable results of one or even several monitors cannot be used to infer what CWA concentrations will exist at other (even nearby) locations due to the random effects of dispersion factors present. Monitoring may not be able to prove or disprove the accuracy of models and plume predictions.

Given technical and operational resource limitations and incomplete knowledge about the magnitude of the event, it is very unlikely that the right equipment could be placed to intercept the plume at a specific position at the appropriate time. However, even if some detectors were available directly in the predicted path of the plume, the results of limited point monitoring would not be adequate to define the plume or change immediate protective-action strategies and recommendations. Proper monitoring methods may determine the existence of residual contamination of items and areas following the predicted passage of the plume.

5. MONITORING SHOULD BE USED IN CONCERT WITH AIR DISPERSION MODELING TO ASSIST IN REENTRY/RECOVERY DECISION-MAKING.

It is critical for emergency managers to use all the tools at their disposal to make emergency decisions. Reliance upon any one methodology to the exclusion of others will limit the application and accuracy of their decisions. Monitoring, modeling, and anecdotal evidence are just some of the methods that can and should be employed by emergency managers. In addition, using a model-developed predicted plume as a starting point, emergency managers will be able to define and prioritize areas where monitoring equipment can be deployed. Air monitoring supplemented by other media sampling results will allow emergency managers to determine the risk of residual CWA to support reentry/recovery decision-making. Careful retrospective deposition modeling, using meteorological data, may be appropriate and may assist in directing the sampling of soil, surface water, and vegetation.

6. MONITORING EQUIPMENT AND OPERATIONS HAVE CHARACTERISTICS WHICH MAY IMPACT OPERATOR SAFETY.

During response/reentry activities, potential exposure to the CWA is generally the main concern. Proper PPE and monitoring must be used to control worker exposure. In addition, emergency workers must also be instructed on hazard identification, use of PPE, CWA exposure signs, symptoms, and emergency procedures/first aid. Several other safety hazards must also be considered before initiating the monitoring tasks. Workers must be given precautionary instructions and emergency procedures for all foreseen dangers.

Emergency managers must consider the potential dangers to the health and safety of emergency workers. Such dangers include exposure to hazardous materials (CWA as well as other hazardous substances), possible fire/explosion, heat stress, etc. A good source of information on local hazards is the Local Emergency Planning Committee (LEPC). Material Safety Data Sheets (MSDS) are an excellent source of health hazard and first aid information.

Discuss each type of general safety risk issue and the type of hazard it represents with the monitoring team. Also describe methods/procedures/equipment, etc. that will be used to minimize the risk associated with each hazard. Examples include the following:

- Chemical Hazards (CWA, other spilled/released chemicals, breakdown products)

- Physical Hazards (explosion, falling debris, etc.)

- Temperature/Climate Hazards (heat stress, hypothermia, frostbite)

- Electrical Hazards (lightning, live wires, equipment usage)

- Operating Hazards (monitoring equipment in hazardous environments, such as explosive atmospheres, dusty atmospheres, oxygen-deprived atmospheres)

CRITICAL DECISIONS

It is clear that in any CSEPP CAI, there will be demands for monitoring data. Preplanning is imperative to ensure priority support is provided to those actions most likely to benefit public health, safety and most likely to benefit from the collection of monitoring data. Mass distribution of monitoring equipment without the ability to appropriately interpret the data has the potential to increase the danger to the public and emergency workers.

The role of monitoring in supporting these decisions will vary from being critical in implementing an activity, to being supportive, or to increasing some subjective comfort level. The ability to obtain useful data from monitoring activities for making decisions will be limited by equipment availability and by other operational factors. Monitoring data from multiple sources should be used in the analysis prior to making decisions. Poor or even dangerous decisions can be made by reliance on accepting monitoring results from a single sample. It must be emphasized that sites need personnel available who are competent in analyzing and interpreting monitoring data.

There will be several decision-making activities occurring concurrently during any CSEPP CAI. For example, on post, individuals responsible for hazard analysis will be trying to develop a broad definition of the event both geographically and over time. Activities such as accident site reconnaissance, deployment of personnel, activities to mitigate/stop any CWA release, and refining the hazard predictions must be conducted. The depot commander may require significant monitoring assets to successfully accomplish these tasks.

Off post, emergency workers (Fire, EMS (Emergency Medical Services), Law Enforcement, Public Works, etc.) will be initiating their response activities. Of critical concern to the off-post authorities will be the rapid and ongoing evaluation of the hazards (CWA exposure, heat, cold, etc.) threatening any personnel operating under their control. Monitoring assets to support work rule decisions are critical at this time to allow activities that appropriately protect workers and ensure that emergency response actions are implemented in a safe and timely manner.

Off post, local public officials in communities close to CWA storage sites will have an interest in ensuring protective actions are implemented in a timely fashion that adequately protects their constituency. While preplanning actions and an effective alert and notification system should be capable of accomplishing this goal, public authorities may request monitoring data be available to assist them in making critical decisions. They also may be interested in determining specific concentrations, dosages, etc., to help them handle inquiries and make informed requests for assistance.

Off post, state health officials may be faced with implementing actions designed to protect the public health and support local medical efforts through a variety of actions. Initiating statewide emergency response actions to support local emergency workers may necessitate having the ability to answer many of the same questions facing the local emergency responders. During post-emergency activities, state officials will face a large array of questions about the lingering public health risk associated with the CAI. Monitoring data capable of supporting a wide variety of actions from emergency response to long-term surveillance may be necessary.

Off-post authorities must make decisions related to the following six critical decision areas. The listed order does not necessarily represent a priority ranking:

1. DETERMINE THE EXISTENCE OF CONTAMINATION:

An important question in a CSEPP CAI is “Is there contamination?” There are great public expectations that sophisticated equipment will be able to quickly provide detailed and precise information. The public wants to know and decision-makers need to know. Unfortunately, the answer is not as simple as “yes or no.” As noted in the assumptions, equipment and sampling methods are not 100% accurate, and decisions will have to be made based on partial or incomplete information.

- **Goals and Objectives:** Monitoring for contamination provides data to support the following decisions**:**

1) Is there contamination of critical assets and facilities?

2) What are the priorities for decontamination?

3) Can something be used: never, not now, limited, unrestricted?

4) Get control over:

 a) facilities (not moveable) - hospitals, dams, schools, and factories;

 b) objects (moveable) - equipment, police cars, ambulances, rather than individuals and animals;

 c) areas such as land, crops, water, roads, infrastructure (see critical decisions four and five); and

 d) people and special/companion animals.

5) Should something be decontaminated? What is the use and priority?

6) Given constraints, can options other than monitoring help make decisions?

- **Assumptions:**

1) GB is non-persistent and will most likely evaporate and be carried away by wind. Off-post monitoring may not be able to find GB.

2) VX and H (Mustard) are persistent CWAs and are the most likely CWAs to be present for monitors to detect.

3) Cold weather will present detection challenges for monitoring. Temperatures below 50 degrees Fahrenheit will freeze HD (32 degrees for HT) and reduce vapor pressure to zero, thereby preventing air monitors from detecting HD. Cold will also reduce VX vapor pressure and reduce the effectiveness of air monitors. Increased temperatures will increase the tendency of CWA to vaporize, making it more likely to be detected in the atmosphere.

4) Observation of birds and small mammals for symptoms of CWA exposure will provide additional information to add to computer projections and monitoring measurements to assess risk of exposure.

5) Areas can be presumed to be relatively free from significant contamination through observing biological indicators, especially where birds and small mammals are present and asymptomatic.

6) Wherever decontamination activities occur, the decontamination solutions/runoff should be considered hazardous until determined otherwise.

- **Strategies and Recommendations:**

1) Individuals with potential exposure to CWA should proceed through a decontamination process and not individual detection/monitoring activities.

2) Monitoring for CWA contamination should be based upon a priority system designed to return the critical public infrastructure to sustainable operation as quickly as possible.

3) Review and revise established control boundaries as required based on monitoring results.

4) Consider multiple monitoring approaches:

a) Send out teams for reconnaissance and sampling based upon priorities and models.

b) Established a system to ask questions and collect data.

c) Observe biological monitors.

d) Develop a protocol for centralized collection and distribution of data and/or reports of CWA exposure. This includes but is not limited to computer models, monitoring results, area reconnaissance, patient evaluation, and citizen reports.

2. DETERMINE THE NEED FOR DECONTAMINATION:

Off-post authorities will need information to decide whether decontamination is necessary for equipment and facilities and if decontamination is effective. Contamination may be known or suspected based on air dispersion modeling, symptoms or monitoring. A rapid and positive determination of contamination through visible means may be difficult and very unlikely because almost all CAI will result in airborne dispersion of CWA as vapors and/or aerosols. Decontamination can be either passive or active. Passive decontamination uses weathering or aging to degrade the agents by exposure to the elements. Active decontamination involves the use of solutions or adsorbents to physically remove and/or neutralize contamination. Porous materials present special difficulties for decontamination. Following decontamination, use of monitors to validate vapor off-gassing may be required. Decisions to conduct decontamination of personnel should not be delayed to determine their status by use of monitoring.

- **Goals and Objectives:**

1) Determine if something (known or suspected to be contaminated based on monitoring, symptoms, or modeling) has been decontaminated.

2) Make a decision to re-initiate active decontamination measures to a facility, object, and area where initial decontamination efforts have been shown by monitoring to be ineffective.

3) Make a decision to confirm effectiveness of passive decontamination measures by use of monitoring techniques and where active decontamination is impractical (large facilities and objects which may be destroyed by active decontamination).

- **Assumptions:**

1) GB is non-persistent and it will most likely evaporate and be carried away by wind before active decontamination can be applied. Off-post monitoring may not be able to find GB.

2) VX and H (Mustard) are persistent CWAs and after a CAI are most likely to be present for monitoring to detect.

3) Cold weather will present detection challenges for monitoring. Temperatures below 50 degrees Fahrenheit will freeze HD (32 degrees for HT) and reduce vapor pressure to zero, thereby preventing air monitors from detecting HD. Cold will also reduce VX vapor pressure and reduce the effectiveness of air monitors. Increased temperatures will increase the tendency of CWA to vaporize, making it more likely to be detected in the atmosphere.

4) Decontamination and prompt treatment of people exposed or potentially exposed to CWA is more important than confirming decontamination effectiveness by use of monitoring.

5) Observation of birds and small mammals for symptoms of CWA exposure will provide additional information to add to computer projections and monitoring measurements to assess risk of exposure.

6) Areas can be presumed to be relatively free from significant contamination through observation of biological indicators, especially where birds and small mammals are present and asymptomatic.

7) Wherever decontamination activities occur, the decontamination solutions/runoff should be considered to be hazardous until determined otherwise.

- **Strategies and Recommendations:**

1) Establish control measures defining “hot zones.”

2) Establish rapid decontamination procedures and prompt treatment for people exposed or potentially exposed to CWA, in lieu of monitoring.

3) Systematically assess the effectiveness of decontamination.

4) Consider multiple monitoring approaches:

a) Deploy teams for reconnaissance and sampling based upon priorities and models.

b) Establish a system to ask questions and collect data.

c) Observe biological monitors.

3. DETERMINE APPROPRIATE WORK RULES

During a CAI, emergency response activities by civilian employees are subject to occupational safety and health rules established in Occupational Safety and Health Administration (OSHA) 29 CFR (Code of Federal Regulations) 1910.120, 132,133 and 134 or rules established by respective state regulatory agencies. Any release of a CWA that is predicted to travel off post is a potential hazard to civilian employees responding to the emergency and requires a determination of the risk of exposure.

CSEPP Policy Paper 2, October 1993, provides that state and local responders may accompany Army sampling and monitoring teams under certain conditions (see CSEPP Policy Paper #2, October 1993 at Appendix E). Existing CSEPP Planning Guidance states that CSEPP community emergency response workers will not be deployed into areas that are known or suspected to be contaminated with CWA until such time that the level of contamination can be determined and appropriate PPE provided. States and local jurisdictions must establish work rules to ensure that the CSEPP community emergency response workers are not deployed without appropriate protection into areas either known or suspected to be contaminated.

Work rules related to emergency response, respiratory protection, and protective clothing require an assessment of the level of exposure to hazardous chemicals on both a qualitative and quantitative basis. OSHA has stated that the Army's D2PC plume dispersion model can be used to identify off-site potentially contaminated areas.[8] However, OSHA makes it clear that the plume dispersion models cannot be used in lieu of an actual off-site exposure assessment. The plume dispersion models can be used only to generally designate zones or areas as one of the following:

1) CWA not present, or

2) Potentially contaminated with CWA.

[8] Letter, Department of Labor, 14 July 1995, subject: OSHA Comments on CDC Recommendations

In areas where there is potential contamination from CWA, exposure assessments are required to be conducted for employees entering these areas. Monitoring provides the basis for actual exposure assessment by checking for the presence and concentration levels of the CWA. Exposure assessments can be made by monitoring directly for the concentration of CWA in the ambient air and/or detecting for the presence of CWA on contact surfaces. If monitoring information is not available about contaminated or potentially contaminated areas, the level of exposure to CWA must be classified as "unknown" and cannot be represented by plume dispersion models.

In areas where the level of CWA concentration is unknown or cannot be determined by air monitoring, selection for respiratory protection and protective clothing becomes limited to the highest level - "Level A." Protective equipment such as clothing and respirators less protective than Level A has operational limitations related to the concentration levels of CWA. PAPRs (Powered Air Purifying Respirators) and APRs (Air Purifying Respirators) cannot be used in contaminated or potentially contaminated areas where air monitoring cannot be conducted. In areas where the airborne concentration of a CWA is uncharacterized, the protective capabilities of personal protective equipment may be exceeded. In 1994, the National Institute for Occupational Safety and Health (NIOSH) and OSHA stated that chemical warfare agents have poor warning properties. The use of air-purifying respirators is not recommended against CWA with poor warning properties. However, in 1995 and 1996 OSHA stated that the PAPRs may be used in a CSEPP response with proper emergency response plans, adequate monitoring equipment, and respiratory maintenance procedures, when IDLH (Immediately Dangerous to Life and Health) levels are not exceeded and a "Buddy System" is in effect.[9]

Air monitoring provides the ability to determine whether PPE such as respirators can offer adequate protection for the level of exposure indicated. In the following typical emergency response activities or tasks in unknown or potentially contaminated areas, air-monitoring-based selection of PPE is essential in the protection of civilian employees:

1) Decontamination of individuals and/or equipment.

2) Medical treatment of contaminated or potentially contaminated individuals.

3) Entry into potentially contaminated or contaminated areas.

If monitoring is available for a specific task, the equipment shall have the sensitivity to indicate whether the operational limits or the assigned protection factors of the personal protective devices are to be exceeded. In the situation where air-monitoring equipment is not sensitive enough to detect IDLH concentrations of CWA, Level A protection is required.

Air monitoring plays an important role when PAPRs or APRs are used by

[9] Letter, Department of Labor, 14 July 1995, subject: OSHA Comments on CDC Recommendations

emergency response personnel in areas contaminated or potentially contaminated with CWA. When emergency response personnel enter areas wearing PAPRs or APRs, adequate air monitoring equipment must be available, unless the area is known not to be contaminated with a CWA. Such equipment must provide a visual or auditory warning prior to the level of agent reaching the assigned protection factor of the respirator.

- **Goals and Objectives:** Support decisions on work rules for off-post chemical warfare agent accidents/incidents where monitoring can accomplish the following:

1) Provide data for exposure assessments for emergency response personnel entering contaminated or potentially contaminated areas and for personnel conducting decontamination to:

a) Determine if exposure levels of nerve agent exceed or do not exceed the IDLH and, therefore, aid in the decision as to which equipment to use.

b) Determine if exposure levels of CWA exceed or do not exceed the airborne exposure limit, and, therefore, aid in the decision as to which equipment to use.

2) Provide data for actual exposure assessments made for the selection of personal protective equipment that:

a) Provides visual or auditory warning that the CWA exposure level is about to reach the assigned protection factor of PAPRs or APRs.

b) Provides warning that the protective capabilities of protective clothing have not been exceeded.

c) Permits emergency responders to downgrade from Level A protection after entering contaminated or potentially contaminated areas of unknown or IDLH concentrations to use PAPRs or APRs when it is safe to do so.

- **Assumptions:**

1) The area inside the designated "protective wedge," as determined by the site-specific dispersion model is considered contaminated or potentially contaminated. The areas outside the designated "protective wedge," including "evacuation zones," are not considered contaminated unless specific information indicates otherwise.

2) The work rules for a CAI are based upon emergency response rules and all applicable safety and health rules. Air monitoring relates to specific health and safety rules involving the use of respirators and other personal protective equipment.

3) Decontamination sites or areas where medical treatment is given to

contaminated individuals may create a hazard or risk of exposure to CWA.

4) Civilian responders will not respond to a CWA CAI site on post.

5) OSHA (HAZMAT work rules) require level A protection when operating in a designated potentially contaminated area, and one has to assume unknown and/or IDLH levels unless it can be shown by monitoring not to be IDLH.

6) Single point-source monitoring can not reliably define open area exposure risk.

7) Personnel who rely on detectors are not free of risk of exposure to CWA, and the closer to the source, the greater the risk.

- **Strategies and Recommendation:**

1) Access control points and personnel processing points (decontamination sites) are to be placed outside the designated protective wedge in clean or uncontaminated areas.

2) Monitoring supports work rules, but there are other sources of exposure assessment data that can be used in determining work rules other than monitoring: reconnaissance, modeling, and biological indicators.

3) Monitoring practices and protocols have to factor in the capabilities and practical limits of available personal protection equipment.

4) Responders must not go into known or potentially contaminated areas without an assessment of the risk of exposure to CWA.

5) Responders must not go into known or potentially contaminated areas without proper evaluation, selection, and use of PPE.

6) PAPRs or APRs cannot be used in unknown areas or atmospheres exceeding the operational limitation of the equipment.

4. DETERMINE WHEN TO EGRESS FROM COLLECTIVE PROTECTION AND/OR SHELTER-IN-PLACE ENCLOSURES

Shelter-in-place is accomplished by shielding the public from the CWA hazard. Shelters may be congregate (for many people) or individual (a home). Shelters may be existing structures (with or without upgraded protective measures) or facilities specifically designed to provide shelter from toxic chemicals. There are four levels of shelter-in-place: normal, expedient, enhanced, and collective protection/pressurized.[10] These are defined as follows:

[10] Planning Guidance for the Chemical Stockpile Emergency Preparedness Program, Page 8-15, May 17, 1996.

– Normal shelter-in-place involves taking cover in a building, closing all doors and windows, and turning off ventilation systems. Effectiveness is improved by going into an interior room. The shelter should be opened up or abandoned after the plume has passed.

– Expedient shelter-in-place is similar to normal shelter-in-place except that, after going into the room selected as a shelter at the time of an emergency, the inhabitants take measures to reduce the rate at which air or CWA enters the room. Such measures would include taping around doors and windows and covering vents and electrical outlets with plastic. Effectiveness is improved if the room selected as a shelter is an interior room. The shelter should be opened up or abandoned after the plume has passed.

– Enhanced shelter-in-place is similar to normal shelter-in-place except that it involves taking shelter in a structure to which weatherization techniques have been applied before the emergency to permanently reduce the rate at which air or CWA seeps into the structure. Effectiveness is improved by going into an interior room. The shelter should be opened up or abandoned after the toxic plume has passed.

– Collective protection, or pressurized shelter-in-place, is similar to normal shelter-in-place except that the infiltration of contaminated air from outside the shelter is effectively prohibited by drawing outside air into the shelter through a filter that removes CWA. This filtered air creates a positive pressure in the shelter so that clean air is leaking out instead of contaminated air leaking in.

Off-post authorities will have to make decisions for the initiation of protective actions. Because of the critical need for the rapid implementation of protective actions, their initiation will be based largely upon prior planning. Off-post authorities will have to make decisions regarding the discontinuance of the sheltering actions and the egress of the occupants.

- **Goals and Objectives:** Off-post authorities will need help in deciding when to notify people to come out of collective protection and/or sheltering in place.

- **Assumptions:**

1) Protective actions (collective protection, shelter-in-place) must be treated very differently.

2) While in a collective protective shelter, the occupants are assumed to be under full protection for the duration of their stay. Egress is not as time-critical, and monitoring can be carried out to ensure it is safe for the occupants to come out.

3) With the non-persistent CWA GB, air monitoring should suffice to determine if it is safe to notify people to come out. With the persistent CWAs HD and VX, it would be appropriate to conduct air monitoring and to consider the potential for surface deposition risks prior to egressing shelters.

4) The practice of sheltering in place requires ventilation of and/or egress from the shelter as soon as possible following passage of the plume. The occupants do not have full protection during shelter-in-place. Contaminated air can seep in and build up during passage of the CWA plume and then decrease slowly after the plume has passed. Therefore, in order to minimize the dosage received by the occupants, it is critical to ventilate the shelter as quickly as possible and get the occupants out of the affected area as soon as possible. Air dispersion modeling of the plume will be more useful for deciding when to notify shelter-in-place occupants to open up their shelters.

5) Shelter-in-place will require different responses for the various CWAs. With non-persistent GB, once the plume has passed, so has the threat. It should not be necessary to monitor to support a post-plume evacuation. However, for the persistent CWAs (VX and HD) which may have deposited, it may be necessary to notify people to ventilate the building and remain in shelter until advised otherwise.

- **Strategies and Recommendations:**

1) Off-post authorities should depend mainly on air dispersion modeling to determine plume passage and when to recommend ventilation and/or egress from shelter-in-place.

2) In the case of collective protection, especially when persistent CWAs are involved, monitoring activities may be implemented to determine if it is safe to allow egress.

3) Off-post authorities should assess factors such as weather conditions, observations, biological indicators, and models to determine egress from protective action.

5. DETERMINE WHEN THE OFF-POST POPULATION CAN RETURN.

Monitoring potentially contaminated areas will be a major tool to determine when it is safe for evacuated persons to return. The volatile characteristics of a GB CWA release would allow for a faster return of the civilian population due to minimal chance of agent deposition based upon area reconnaissance. The persistent CWAs VX and HD will require a more detailed monitoring plan, to include area reconnaissance, soil, and water sampling, to develop the degree of satisfaction necessary to satisfy the off-post authorities that the return of the off-post population is safe. Every effort should be made at the local level to develop plans concurrently with federal, state, and local environmental and health authorities to create a mutually acceptable approach that allows for monitoring. In any case, with the possible exception of a GB release, several days or weeks may lapse before unrestricted reentry can be realized.

- **Goals and Objectives::**

1) Conduct follow-up monitoring to determine the extent of contamination to allow off-post authorities to decide whether to reduce the size of the

evacuation area.

2) Determine if there is off-post deposition of CWA.

3) Determine the limit of the off-post deposition of CWA.

4) Provide civilian officials with necessary data to help decide when evacuated personnel can return. The following categories of return as defined in Appendix M, CSEPP Planning Guidance, apply:

a) Emergency workers (vapor risks, level 8 hour TWA(Time Weighted Average), sample risk areas, and sample in high-risk environment – no wind, rising temperature).

b) Restricted return – allow the population to return to their homes on a short-term basis (vapor risk, level of GPL (General Population Limit), level 8 hour TWA, sample risk areas, and sample in high risk environment).

c) Unlimited return (other than vapor sampling – soil, biota, water; level).

- **Assumptions:**

1) Return of evacuees outside of the designated protective wedge may be accomplished based on modeling without the benefit of monitoring.

2) When the designated protective wedge has been revised due to an update based on reconnaissance of the accident site and other data, people may return without the benefit of monitoring to that part of the protective wedge determined not to be affected by CWA.

3) Precipitation significantly reduces vapor hazards, but may increase the risk of ground contamination[11.]

4) CWAs degrade over time.

5) Consistent calibration methodologies are essential for monitors.

- **Strategies and Recommendations:**

1) After an evacuation, monitoring may support the areas where populations are allowed to initially return.

2) After an evacuation, the areas where populations are allowed to return

11 Hanna, Briggs, Hosker, Handbook on Atmospheric Diffusion, Technical Information Center U.S. Department of Energy, 1982

may be classified as restricted reentry (protected emergency workers with equipment and training), occupational reentry, and emergency reentry. These forms of reentry refer to the temporary, short-term re-admission of persons (primarily recovery workers or monitoring teams). Unrestricted reentry is used in the context of unlimited permanent re-access, re-occupation, or use by the general public of previously restricted areas and objects after the hazards of CWA exposure have been reduced to acceptable levels.

3) The potentially contaminated areas will be reviewed continually to reduce the size of the areas classified as restricted and restricted return, as soon as practical and based on models, reconnaissance of the accident site, weather, time, and distance from the source, and may be supported by monitoring (active and biological).

6. DECISIONS RELATED TO SPECIAL MONITORING CASES. Not all decisions, such as public perception and confidence, return to high-value equipment and property, and the evacuation of occupied shelters or facilities not previously evacuated, will fit into the previous categories. The public's confidence and perception will be enhanced by actually seeing the monitoring activities taking place and dissemination of the results being used in the decision process.

- **Goals and Objectives:** Guide off-post authorities in handling requests for unstructured and unsystematic monitoring.

- **Assumptions:** This category of monitoring could aptly be named "other" as it applies to those questions asked by designated off-post authorities regarding perceived risk of CWA exposure to their citizens, property or environment. Special monitoring cases are of an inherently lower priority than the five previously mentioned.

- **Strategies and Recommendations:** The critical considerations of this category are as follows:

1) Planning. Advanced planning can determine monitoring requests most likely to be made based upon local knowledge of people and perceptions through tabletop exercises. To prevent the special cases category from overwhelming other decision-based monitoring requirements, it is essential that off-post authorities prioritize these categories of requests.

2) Control**.** To prevent diverting monitoring resources from other critical decision-based monitoring requirements, it is essential that off-post authorities evaluate and prioritize these requests. Diversion of available monitoring resources to undertake unstructured and unsystematic monitoring can actually negatively affect public confidence in the emergency response.

Determination of Appropriate Monitoring Equipment – Site-specific Critical Decisions can be used to identify applicable monitoring equipment by the development of mission parameters and the Appendix C Equipment List (*See figure 2*). The flow chart represents a list of questions that need to be considered in the determination of appropriate monitoring equipment.

Redefine critical decision/mission

1. *Can the critical decision be supported without monitoring?* Monitoring for any effort requires resources and adds complexity; therefore, the emergency manager should always consider any option that allows the critical decision to be supported without monitoring. Strategies and recommendations are presented for all of the previously listed critical decisions.

2. *What is the mission of the required monitoring task?* Defining the precise mission is imperative to identifying monitor requirements. The emergency manager should consult his concept of operations and critical decision strategies and recommendations.

3. *What are all of the required performance parameters for the specific detector to support the critical decision?* A list of parameters along with aids to determine appropriate values for the parameters is included in Appendix C. An example of parameters for a mission is also provided at enclosure 1.

4. *Compare the list of parameters to the equipment performance chart in Appendix C.* An example of this comparison and the resulting charts is provided in Appendix C.

5. *Evaluate the best candidates by determining the criticality of the performance parameters not met by the equipment.* The equipment must be fully able to support the critical decision without introducing factors that could compromise the effectiveness of the effort.

6. *Select appropriate monitor or re-evaluate/modify critical decision/mission*.

Determination of Appropriate Monitoring Equipment

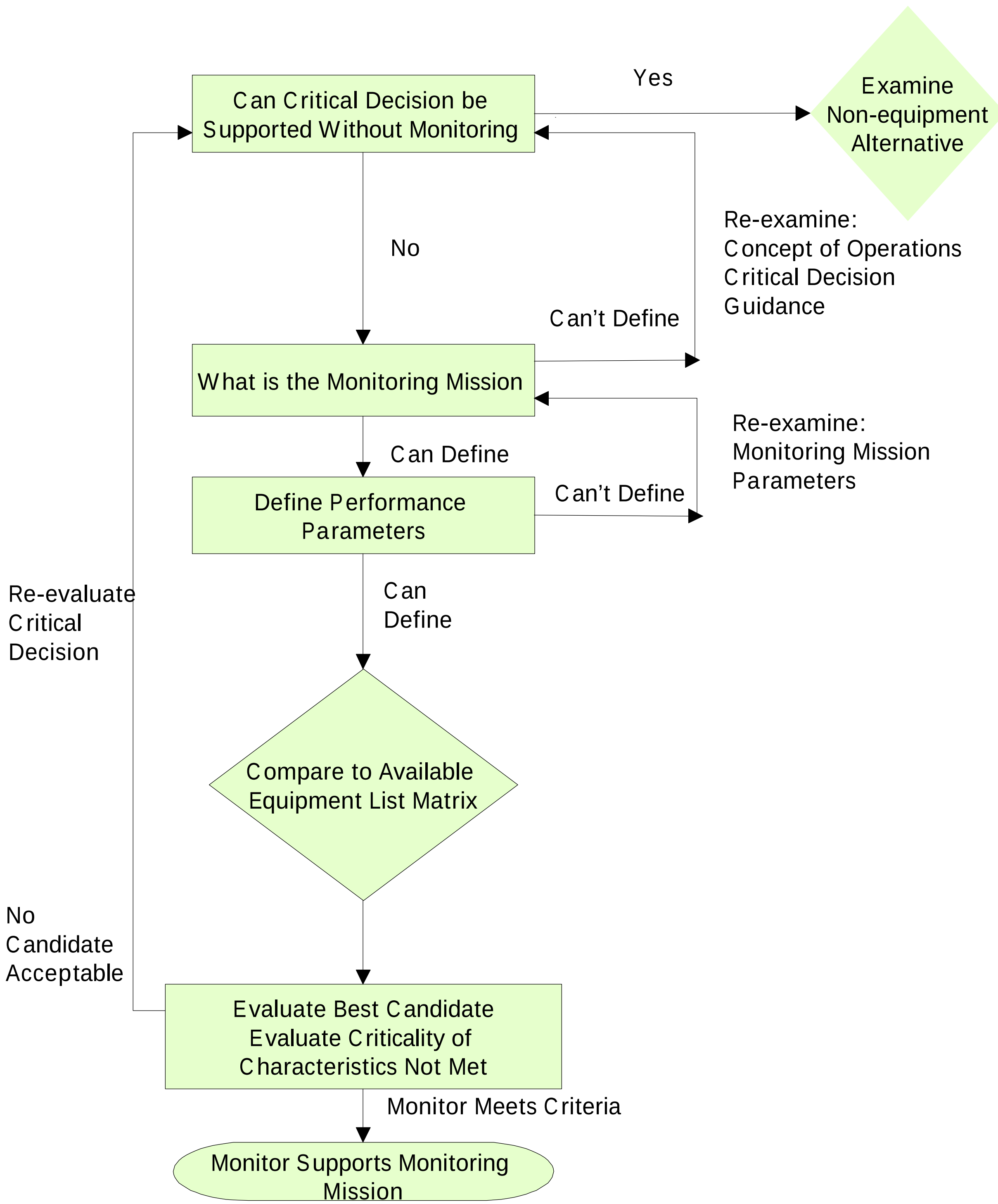

Figure 2

CONCLUSIONS

After research, review, and analysis of a considerable body of information (a partial listing of information that we reviewed is attached as Appendix F), the IPT concludes that the most helpful approach is to identify common factors and provide information of a non-directive nature in this guidance. The most effective approach to implementing monitoring is one that is accomplished at the local level. We conclude the following:

– **Each site needs to develop a coordinated off-post monitoring plan**. It is essential that at each CWA storage location a coordinated off-post monitoring plan, and agreement, be developed that address the coordinated actions to be taken in the event a CAI occurs. Coordination must include the Army, counties, state, and federal agencies. The agreement should define the expected equipment, procedures, and coordination. It should separate response requirements from recovery requirements.

– **Monitoring resources will always be limited**. Therefore, emergency managers should limit monitoring efforts to support critical decisions whenever possible. We believe that planning and development of a coordinated off-post monitoring agreement can be aided by use of the issues, assumptions, critical decisions, corresponding strategies and recommendations, and appendices identified in this report. These critical off-post decisions can be tailored and amended to more directly apply to each specific site.

– **Monitoring plans need to be exercised**. Test the monitoring plan that is developed. Become familiar with the methods and equipment that is available (i.e., where should equipment be located, how should it be maintained, calibrated, used, and disposed of). Understand the relationship between and need for models and actual monitoring.

Each site should establish a plan detailing estimated availability and need for monitoring requests. Monitoring assets should be dispatched from a single point of contact established prior to the event to ensure coordination and control. Flexibility is essential as requests may impede the ability to respond to higher priority concerns and decision needs of civilian authorities. All monitoring results should be reported to a single reporting station for dissemination to all interested agencies.

We have endeavored to make this guidance specific enough to be useful while being general enough to apply to each site. The members of the IPT accept the fact that the guidance may not satisfy all readers. However, we believe it is sound and represents the collective best professional judgment of the members (Appendix G).

APPENDIX A

CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM RECOVERY SAMPLING AND ANALYSIS PLAN PROTOCOL FOR CHEMICAL WARFARE AGENTS ACCIDENTS/INCIDENTS

CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM
RECOVERY SAMPLING AND ANALYSIS PLAN PROTOCOL
for
CHEMICAL WARFARE AGENTS ACCIDENTS/INCIDENTS

prepared by

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U.S. Army Center for Health Promotion and Preventive Medicine

June 1998

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CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM (CSEPP) RECOVERY SAMPLING AND ANALYSIS PLAN (RSAP) PROTOCOL for CHEMICAL WARFARE AGENT (CWA) ACCIDENTS/INCIDENTS

SECTION I

1. PURPOSE.: The purpose of this document is to provide guidance to the Chemical Stockpile Emergency Preparedness Program (CSEPP) communities on how to establish site-specific Recovery Sampling and Analysis Plans (RSAPs). As this guidance uses example and some theoretical information, SPECIFIC DETAILS SHOULD NOT BE CONSTRUED AS ARMY-POSITION/POLICY. A site-specific RSAP must be developed, reviewed, and approved by the appropriate Army, Federal, State and local representatives.

2. APPLICATION. Specifically, this guidance is presented in the form of a protocol (Section II) that provides the guidance and information necessary to develop and execute an RSAP as required in Department of the Army (DA) Pamphlet (PAM) 50-6. The RSAP itself will ensure that reentry/restoration decisions associated with a Chemical Agent accident/incident (CAI) are determined through appropriate scientifically-based evaluations of public health and the environment. The CSEPP communities can use this protocol as a tool for developing site specific RSAPs. The protocol was written in the outline of an RSAP, however, some key information will need to be filled in by the local CSEPP working groups in order for it to be complete. For purposes of demonstrating how the protocol can be implemented, Section III provides an example of a site-specific RSAP.

3. BACKGROUND. In 1988, the CSEPP was established in response to Public Law 99-145 which directed the Department of Defense (DoD) to destroy the stockpile of chemical warfare agents (CWA). The DoD currently stockpiles CWA at eight U.S. Army Installations located throughout the continental United States. With the anticipated increase in CWA activities at the stockpile sites, the CSEPP was started to enhance and prepare local community emergency response units for any CWA accident/incident (CAI) which may occur at these installations. In 1997, CSEPP established the Off Post Monitoring Integrated Product Team (OPMIPT). The OPMIPTs role is to prepare guidance for establishing plans necessary to fulfill CSEPP's mission. One such plan is the RSAP. This plan is to detail the methodologies, analytical/laboratory requirements, and data evaluation approach necessary to allow reentry into CAI areas. In the past, a CAI exercise consisted primarily of the initial response to the

release and concluded when the release was contained. Little consideration was given to the after effects of such a release to the surrounding communities and how they would be impacted by CWA contamination. Due to increased awareness resulting from the inception of CSEPP, more emphasis and attention has been placed community preparedness and readiness response to include recovery/reentry activities after an CAI event (reference 1). The CSEPP community at each of stockpile installations has been tasked to prepare an RSAP specific to their needs/locale. The status of the RSAPs varies at each site. To facilitate the RSAP preparation process, the IPT has tasked the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) to prepare a protocol from which RSAPs can be developed. The principle behind the development of this protocol was to provide a basis from which RSAPs can be developed based on Army Regulation (AR) /DA PAM 50-6 (references 2 and 3). In DA PAM 50-6, the U.S. Army outlines the requirements for responding to an CAI from initial response to site remediation and environmental monitoring. While providing this guidance and specifying monitoring requirements, there are no direct guidelines detailing how recovery/restoration efforts are to be executed. Rather, guidance comes in the form of following U.S. Environmental Protection Agency (EPA) approved procedures. Currently, the EPA does not specifically regulate CWA nor have they approved any procedures, methods, or cleanup standards specific for CWA, although several states now require CWA wastes to managed as hazardous wastes. The DA has various procedures in place for decontamination and disposal (AR & DA PAM 385-61, references 4 and 5). Currently, the DA Steering Committee for Standards in Emergency Response, Remediation, Restoration, and Demilitarization of Chemical Warfare Material (SCS) is reevaluating existing procedures and refining the guidance to include specific concentration levels for screening various environmental media.

4. OTHER GUIDANCE/REFERENCE SOURCES. In addition to this protocol, other existing CSEPP guidance on reentry/recovery issues should be referred to when developing an RSAP. Specific key documents are listed in Appendix A, References.

SECTION II

1. THE PROTOCOL FOR DEVELOPING A RSAP.

a. Stockpile installations typically have ‘likely’ CAI scenarios developed as part of their planning requirements under the Army’s CAIRA procedures. Information from these ‘incident scenarios’ as well as site-specific background information should be used in conjunction with this protocol to complete site specific RSAPs. The sampling strategies that follow have been written such that they can be applied to any CAI. The foundation of these strategies are based on statistics and recommended EPA sampling guidelines and techniques. The protocol as written, is highly adaptable AND SHOULD NOT BE CONSTRUED AS FINAL POLICY OR POSITION. It is provided as guidance only. The number of samples required for each specific sample media (i.e., wipes, soils, air, water, miscellaneous) will be specific to each CAI. The numbers of samples required to be collected represent the level of confidence in any said declaration of an CAI area. The more samples collected, the higher degree of confidence; but sampling requirements will have to be balanced with analytical laboratory capacity and time constraints. The equations and references used to develop the numbers herein can be modified to meet each specific scenario need. When implemented, well executed RSAPs will provide the technical basis to ‘clear’ areas for reentry and identify potential areas of concern which will require more detailed evaluations. Due to the significant time and effort involved in collecting and documenting the background information required for an RSAP and coordinating decisions and approvals amongst the Army, Federal, State, and local representatives, IT IS CRITICAL TO DEVELOP A DETAILED RSAP BEFORE A CAI OCCURS.

b. The following sections provide an outline of the information that should be contained in an actual RSAP. Each section describes certain issues, information, or procedures that should be considered and documented in a site/event-specific plan. Section III includes an example of the procedures and type of information to be documented. This example was based on information from the Pine Bluff Arsenal (PBA) (reference 6). Users of this protocol should complete each section with site/event-specific information.

2. RSAP TABLE OF CONTENTS. An example table of contents of an RSAP is displayed in Figure 1 below. A detailed discussion of the information needed in each section follows:

Figure 1. Example Table of Contents

- ♦ PURPOSE
- ♦ KEY POINTS OF CONTACT AND RESPONSIBILITIES
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- ♦ SITE BACKGROUND INFORMATION
  - General Site Description and Location
  - Local Demographics and Land Usage
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- ♦ INCIDENT INFORMATION REQUIREMENTS
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    - - Emergency/Mitigation Pprocedures
- ♦ INCIDENT-SPECIFIC SITE EVALUATION
  - Environmental Pathways
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- ♦ SAMPLING STRATEGY
  - Goal
  - Identifying Sample Locations
  - Site Selection Process
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- ♦ ANALYTICAL/LABORATORY REQUIREMENTS
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- DATA EVALUATION
- OTHER PROJECT MANAGEMENT REQUIREMENTS
  - Organizational Roles and Coordination
  - Supplies
  - Site Safety and Health Plan
  - Data Interpretation and ReleaseDecision Documentation
  - Risk Communication

3. PURPOSE. The purpose of the RSAP is to detail the methodologies, analytical/laboratory requirements, and data evaluation approach necessary to make prudent, scientifically defensible reentry/restoration decisions regarding Chemical Agent accident/incident (CAI) areas. Specifically, the RSAP designates the specific procedures to be used to collect the necessary information to perform scientifically-based evaluations of health impacts from potential residual chemical agent contamination. The plan also identifies the information and procedures necessary to document evidence of any past presence of chemical agent through residual breakdown products.

4. KEY POINTS OF CONTACT AND RESPONSIBILITIES. The RSAP must identify specific names and organizations associated with its development, approval, and implementation. Phone numbers should also be included. This information may be contained in the body of the RSAP or as an Appendix.

5. ASSOCIATED DOCUMENTATION AND REFERENCES. Several existing documents (such as those referenced in this protocol) are available to address specific CSEPP issues to include policies and technical references. In addition to these, specific documents contain site-specific information, AND event-specific information can be cited. To the extent possible, all such information sources should be cited/referenced to ensure consistency and avoid the necessity to duplicate already documented information. This information can be consolidated in an Appendix.

6. SITE BACKGROUND INFORMATION.

a. General Site Description and Location. Site location directly impacts the extent of sampling that will be required. The number of samples that will be collected is dependent both on the size of the CAI and on the surrounding locale (i.e. land usage, nearby towns/cities, industry, etc.). These will not only impact the number of samples to be collected but may impact the priority and types to be collected. Sites located in more isolated area should focus primarily on soil and water sampling activities. Whereas, sites located in more populated and developed areas will need to focus on wipe, air, and miscellaneous sampling activities in addition to soil and water sampling. The RSAP should include a site map and describe the general characteristics of the surrounding area. Specifically, actual agent storage location in relationship to the installation boundaries as well as specific nearby towns/cities and other, should be demonstrated.

b. Local Demographics and Land Usage. A discussion of the general population and activities surrounding the site will provide incites as to where sampling locations may need to focus or at least accommodate. Specifically, the following information should at least be summarized and documented:

(1) Populations of Concern. The RSAP should include a discussion of different communities and/or activities involving distinct sub-populations that may be of particular concern and/or susceptibility to include elderly groups (convalescent centers) , children (day-care centers, schools, playgrounds).

(2) Key Land Areas/Uses of Concern. In addition to populations and specific activities that may impact sampling decisions, other land uses such as farming and specific agricultural use activities, and recreational areas should be identified. As discussed in other CSEPP guidance (reference 25), it is particularly essential that CSEPP sites be prepared to 'prove' safety of key agricultural products and land uses that affect local economy. The ramifications of potential 'embargos' on such resources could be potentially quite significant, even if chemical agent contamination had not occurred - to avoid 'perception' based reactions, sampling design should ensure that some 'hard data' will support claims of no-risk or no-contamination.

(3) Other Political/Public Concerns. It may be wise to consider other political/public concerns such as those of vocal activist groups - different perspectives should be considered *before* sampling actually occurs - otherwise the 'acceptability' of the sample results and conclusions based on the results may be questioned.

c. CWA and Stockpile Characteristics . Stockpile sites are required to assess the potential hazards and dangers associated with the specific CWA/Chemical Warfare Munitions (CWM) operations located on the installation. This essentially entails reviewing what CWA are maintained on the installation and how they are handled/stored. The RSAPs will need to be prepared such that they address all stockpile CWA that are determined to be present. Specific information regarding the CWA(s) (e.g. toxicity, chemical characteristics, environmental fate) should be identified in the RSAP. This can be accomplished by simply referencing other key documents [e.g. Material Safety Data Sheets (MSDSs); CHPPM Tech Guide 218 Detailed and General Fact about Chemical Agents; Army Field Manual (FM) 3-9, etc.].

d. Environmental Setting.

(1) Climate. The affects of the climatic conditions on the sampling plan will only be known when or after the CAI has occurred. 'Likely' scenarios have been developed taking into account the typical conditions at any one time. Air dispersion and soil deposition models are used to identify potentially impacted areas. For preplanning purposes, these allow for the number and types of potential samples that will be collected to be estimated. Unfortunately, nature may not follow a 'likely' scenario. As such, if an CAI does occur, extreme climatic conditions (e.g. thunderstorm, tornado, hurricane, etc.) would dramatically impact the implementation of the RSAP.

(2) Topography. Special terrain features should be identified. Local terrain may impact the CAI deposition model. High points such as hills, mountains, and forests may steer CWA laden winds around areas while low points such as gullies, valleys, and basins might pool and collect CWA clouds or serve as channels funneling CWA clouds down and away from the release point. The sampling grid will cover the general deposition area, but these terrain features located within this area deserve attention since the area impacted by the plume may not be identified by the model. Therefore, it will be necessary to ensure these areas are adequately evaluated for how they may potentially impact or require adjustments to the RSAP. By identifying these locations prior to an CAI, implementation of the sampling plan will be facilitated.

(3) Surface Water. In the event of a CAI, it will be necessary to evaluate deposition of CWA at surface water locations. All surface water locations surrounding the stockpile site should be documented prior to an CAI. These should include rivers, large streams, and lakes with special emphasis being placed on ones being used for recreational and commercial activities. Again. by identifying these locations prior to a CAI, implementation of the sampling plan will be facilitated.

(4) Groundwater. While in most cases it is unlikely that groundwater would become contaminated, certain types of incident release and hydrogeological conditions should be evaluated to ensure that this is not a significant environmental media of concern (reference 7). These will in all likelihood will not pose an immediate threat due to the inherent movement rate of ground water (upperbounds of 100-200 feet/day). Potential ground water contamination should be evaluated on a site specific basis.

(5) Soils. The types of soil found in the outlying areas surrounding the stockpile installation will not bear any immediate impact on the sampling plan. The CWA that are maintained will impact what information is needed, specifically background sampling. In general, background sampling should not be needed. Chemical warfare agents and their breakdown components are unique enough such that there should not be any interferences by which false positives or negatives will occur. In the case of Deseret where Lewisite is stockpiled, average soil concentrations of Arsenic should be determined since the current means of measuring Lewisite concentrations in any media is via total Arsenic. Background concentrations of arsenic may be documented in scientific literature, thereby, eliminating the need to actually collect background samples (reference 8).

7. INCIDENT INFORMATION REQUIREMENTS. When the amount and types of agent that have been released have been determined, the path and size of the plume should be modeled using an atmospheric dispersion (e.g. D2PC, reference 9) and soil deposition (e.g. GAPCAP) models. These programs do not take into account topography and such but will give a quick, conservative estimation of the CWA plume and resulting ground deposition. Models will predict the area impacted by the CAI which will dictate the number, types, and priority of sample collection. Field reports which indicate the presence or passage of the CWA plume should be noted for possible miscellaneous sampling activities. Reports or rumors of CWA presence outside the model area should be reviewed on a case-by-case basis taking into consideration the location from which the report originated with respect to the initial release

site, geographical features laying between the two areas, and the demography of the area in question. The RSAP should summarize the key information described and reference other documentation established in response to the incident. Specifically, the information should include a general description of the incident, the agent type, amount, type of release, fires/other transport mechanisms involved, description/reference to the Hazard Analyses (Release Modeling), and summary of initial emergency operations/mitigation actions taken (to include what areas were evacuated).

8. INCIDENT-SPECIFIC SITE EVALUATION. Based on the incident information described in Section 7 and the site background information described in Section 6, one must evaluate the situation for determining potential health impacts both from direct or indirect exposure to CWA.

a. <u>Exposure Pathways</u>. Exposure pathways are routes in which persons of animals can be potentially exposed to a given chemical. These ‘pathways’ include the three modes by which chemical contaminant may enter the human body: ingestion, inhalation, and dermal absorption. A ‘completed’ pathway is one where there is deemed a contaminated source media (soil, water, air, and surfaces) and conditions allow contact with the contaminated source through the pathway in question.

b. <u>Exposure Sources</u>. Exposure sources are routes in which persons or animals can be potentially exposed to a given chemical concern. In the case of a CAI, a CWA plume may be released to the surrounding countryside. As the plume passes and dissipates, CWA may volatilize and never impact anyone. It is possible, however, that CWA will precipitate from the plume contaminating some area of land. This results in some amount of CWA being deposited on buildings, automobiles, trees, fields, etc. By evaluating these media, we determine the sources that have the greatest potential for impacting the general population. And in doing so, determine what we need to sample. For CAI, the following sources of exposure have been identified: soil, structural surfaces, surface water, and air. A fifth category called miscellaneous has also been established. This category will be used to address stockpile site specific locations.

(1) Soil. In most cases, the majority of surface area to receive CWA deposition, if any, will occur on surface soil. Persons and animals come in contact with surface soil on a daily basis. Since the area of deposition may occur over a large area, various types of activities, hunting, farming, recreation, etc. may be impacted. Surface soil samples may be collected and analyzed in order to evaluate this pathway. These samples will be collected from a cross section of the impacted area. Sample points will be determined with the use of a sample grid.

(2) Structural Surface. The source of exposure will be from CWA deposition on buildings and structures. These will consist of residential dwellings, office buildings, commercial activities, and automobiles. This source of potential exposure will be the most critical since some of the surfaces exposed (i.e. glass) to CWA deposition will absorb little, if any, of the material. Chemical warfare residues will potentially remain on these surfaces until absorbed, washed or removed via decontamination solutions, naturally degraded, or until it is come in contact with by a person or animal. Wipe samples will

be collected and analyzed in order to evaluate this pathway. Although, wipe samples will be collected only from nonporous media, data generated from these analyses may be used to evaluate exposure via porous/semiporous media in the immediate vicinity. Wipe sample locations will be determined statistically but will be biased to sensitive populations (hospitals, day-care facilities, schools, etc.).

(3) Surface Water. Existing weather conditions will play a major part in where and how many water samples to collect. There are two types of water, lotic and lentic. Lotic describes fast-moving, nonstationary water (e.g. rivers and streams). Lentic describes stationary, nonmoving (e.g. ponds, marshes). For lotic waters, obtaining a representative sample will be difficult (reference 10). Any CWA deposited on the water surface will be swept downgradient. The sheer volume of water will serve to dilute the CWA to levels well below any detectable concentrations. Exposure via lotic waters should be considered complete, but a minor source given the dilution that will occur. For lentic waters, CWA deposited in the surface will not be mixed and carried aware by the water. Rather, it will collect on the surface and diffuse into the water. Diffusion is a slow process. Chemical warfare agents may be diluted, hydrolyze, and/or form a film on the surface. Surface water samples will be collected and analyzed from identified locations in order to evaluate this pathway. Surface water locations to be sampled will be determined statistically.

(4) Air. In place sheltering is the primary means of protection when a CWA release initial occurs. Persons are to remain in place until further instructions are issued. This assumes at some given point that these persons will be evacuated from their location to an area outside the impacted area. Remaining in place until the entire CAI has concluded is not an option. One study (reference 11) has indicated that the initial protection provided by in place sheltering is superior to no protection. However, due to convection currents and such, indoor CWA concentrations increase and persist longer than outdoor concentrations. Air sampling will determine whether the indoor concentrations of CWA are safe prior to building reoccupancy. This sampling will determine whether or not indoor areas need to be decontaminated in any way. Buildings and structures to be sampled will be determined statistically but will be biased to sensitive populations. Note: air monitoring will probably occur prior to entering structures. Air monitoring cannot be used as a substitute for air sampling. Monitoring will occur primarily to ensure sampling personnel safety while conducting sampling activities.

(5) Miscellaneous. The exposure pathways listed above for the most part identify the major exposure scenarios. This section should contain those pathways which are unique to the stockpile site in question. These might be certain food crops, farms, large schools, etc. Special attention should be given these to ensure that pathways specific to these types of facilities/institutions are either adequately addressed via sampling or through management controls (e.g. disposal of potentially contaminated food items) for one of the above pathways or via the miscellaneous sampling route (reference 1). Though these types of samples may be desirable for certain assessment purposes, be aware that analytical capabilities may be particularly limited. In addition - there are no standard criteria/methododolgies for assessing the 'significance' of risk to or from of these types of 'special media,' and if attainable, these results will generally require a very detailed risk assessment. Such samples should only be taken if deemed absolutely

necessary (to answer key public health concerns). If the conditions at the site/incident (see section 5) suggest that ground water could potentially become contaminated, then contingency sampling requirements would have to addressed.

9. SAMPLING STRATEGY. Questions such as "What should be sampled?", "Where to sample?", and "How to sample?" are addressed in the sampling strategy which should contain the following components:

a. Goals. The goal of sample collection will be to determine the presence/deposition of CWA which may result in an immediate (acute) and/or long-term (chronic) health effect to the surrounding population resulting from the CAI. Sampling will also be designed to identify areas where contamination may have existed initially but has broken down into more environmentally persistent compounds. This will be accomplished by collecting a number of environmental samples from predetermined and vital areas both within and outside of the CAI area. Health officials will then use the analytical data to determine whether impacted areas are safe for reentry and to what extent remediation is required using health based standards for CWA/byproducts.

b. Identifying Sample Locations.

(1) Selection schemes. Sample locations will be determined using a combination of the three following sampling schemes:

(a) A systematic grid approach (search sampling) (reference 12) will be used to determine specific sample locations across the impacted area. Soil samples will be collected at each grid coordinate " 100 feet.

(b) A statistical approach will be used to determine the number of wipe, water, and air samples that are to be collected from within each active grid (reference 13).

(c) A biased sampling approach will be used to collect miscellaneous samples throughout the impacted area to address key populations and/or land areas of concern (as described in Section 8b) that could potentially be exposed (as determined in Section 7) as well as to address specific findings (e.g. dead animals and wilted plants outside of the immediate release area) and unusual areas (e.g. gullies, forests, ponds) that the model cannot account for within the impacted area.

c. Site Selection Process. The area located within the immediate response zone (IRZ) will overlaid with a grid (Figure 1). This can be accomplished using the global imaging system (GIS). Sample maps can prepared prior to the CAI to allow easy application of an appropriate grid.

(1) Implementation of Grid Areas. Based on the deposition models, the grid areas that have been impacted by CWA will require sampling. The deposition area should be completely surrounded by grid

vertices which fall outside this area. Grid vertices located within 0.5 miles of the deposition should be sampled to include the areas within the grid acting as a buffer zone. Grids located within the IPZ which require sampling of any sort are designated as 'active.' From within the active grid areas, air, wipe, water, soil and miscellaneous samples will be collected. It may be necessary to extend sampling activities into other grid areas thereby making them active. If samples collected on the outer fringe of the grid area are positive for CWA, the grid will be expanded outward until active grids fully encompasses this 'hot spot.' Rumors or field reports of CWA presence outside the grid area will require review. Based upon review, these may be determined to be coincidental to the CAI. If, however, they are deemed valid, the grid area which has been identified will hence become active until sample results prove otherwise.

(2) Grid Zones. Plumes of CWA will initially be a 'compact mass' when released. As the plume moves further from the release point, the CWA will become more evenly distributed covering a much larger area. The zones closer to the release point should be expected to have higher levels of CWA deposition. Chemical warfare agents deposited in the zones furthest from the release point will, for the most part, be more evenly distributed. Hence, sampling efforts closer to the release point will be more intensified. The CWA deposition will occur over a much smaller area and will not be as evenly distributed or dispersed. Identification of the 'hot spots' will be more crucial due the expected higher concentrations of CWA. Zones further away will be sampled less extensively. The CWA deposition will cover a larger area and be more evenly dispersed. The identification of an 'impacted area' is more critical. The IRZ was divided into four zones - A, B, C, and D. The Zone A radius will be 0-0.5 miles (0-805 meters), zone B 0.5-1.5 miles (805-2414 meters), zone C 1.5-3.5 miles (2414-5632 meters), and zone D 3.5-9.5 miles (5632-15288 meters) (Figures 2 and 3). In the event that deposition were predicted outside the IRZ, the Zone D grid system should be extended out until the area has been incorporated into the grid system. The density or number of samples collected will vary within these zones. The closer the zone is to the initial release site, the greater the number of samples or from a statistical standpoint the less room for error. Zone D will encompass the outer fringes of the deposition area where CWA concentrations would be expected to be the lowest.

(3) Soils. The number of soil samples that will be collected will be dependent on the zone from which the samples are to be collected. The IRZ having been divided into four zones will be subdivided into triangular grids to identify specific sample points. The distribution of CWA deposited will vary the greatest nearer the initial release point. As one moves away from the release point, CWA will be more evenly deposited over a greater area. Hence, the sampling grids will be smaller nearer the release point. Table 1 lists the grid sizes for each zone. The grid sizes were selected to ensure that the chance of missing CWA is minimized. Plumes will distribute CWA typically in a semielliptical patterns over a large area. The length and width of the plume will vary with the environmental conditions and CAI. Hence, the size of the grid will determine the likelihood of finding various CWA deposition 'hot spots' (reference 12). Table 1 also lists the confidence level for detecting and 'hot spot' with the listed dimensions. 'Hot spots' of smaller dimensions may also be detected with the listed grid sizes. However, the confidence level for finding smaller areas of deposition decreases with their respective size.

Table 1. Sampling Grid Dimensions.

Area	Grid Size (meters)	Deposition Area (meters) [1]	Confidence Level (%) [2]
Zone A	201	301 x 160	90
Zone B	402	602 x 321	90
Zone C	805	1203 x 642	90
Zone D	1609	2406 x 1284	90

1 - Deposition area is defined as an elliptical hot spot with the long axis being 75% and the short axis being 40% of the grid length (reference 12).
2 - Confidence Level, likelihood of sampling efforts to identify deposition area of given size.

(4) Wipes. The number of wipe sample locations will be dependent on the number of building structures located within each of the four zones. This number will be based on proportions. This is an estimation of the percentage (proportion) of the population which possess or does not possess some given property (reference 13). In this case, we are concerned whether or not any CWA contamination exists and, if so, how much. The number of sample locations within each of the zones is determined using the proportions calculation. Several variables exist within this equation. The values of these variables dictate or translate into acceptable error. The more conservative they are, the less chance for the sampling to be inadequate. The variables used are listed in Table 2. For example purposes, 100 structures were assumed per area. Table 2 displays the number of locations that would need to be sampled to properly assess the CWA contamination (if any) with the given assumptions. Equation 1 is used to determine the number of sites to sample:

$$n = [\, N (Z^2_{1-\alpha/2}/\Delta^2)P(1-p)]/[(N-1)+(Z^2_{1-\alpha/2}/\Delta^2)P(1-p)] \qquad (1)$$

n = sample size (fractions rounded up)
N = Population Size
P = population proportion (assumed worst case = 0.5)
p = sample proportion (assumed worst case = 0.5)
Δ = amount of error (precision) allowed in p estimate of P; error = /P-p/
α = probability allowed that error will exceed Δ (confidence level)
$Z_{1-\alpha/2}$ = standardized normal deviate for an area totaling α at the tails

Table 2. Zone Wipe Sample Locations Determination.

Area	Grid Size (meters)	" (%)	) (unitless)	Structures Sampled within Zone(%)
Zone A	201	95	0.10	50
Zone B	402	95	0.20	20
Zone C	805	90	0.20	15
Zone D	1609	80	0.20	10

Based on these values, 50% of the structures will be sampled in zone A, 20% in zone B, 15% in zone C, and 10% in zone D. For sampling purposes, all structures regardless of their size are equal for counting purposes. Two wipes sample should be collected per structure. One sample will be collected outside of the structure, and the second wipe should be collected inside the structure. These should be collected from smooth surfaces which are considered nonporous such as glass, kitchen countertops (tile), and/or exposed metal. Wipe samples collected from porous materials may underestimate CWA surface concentrations due to absorption. Samples collected from materials other than glass or metal may be dissolved by the collection solvent when trying to collect samples. Outside samples should be collected from surfaces that face the direction the plume originated. Indoor samples should be collected from area located near open windows, ventilation ducts, door cracks, etc. Samples nearer the floor and in rooms where children might spend the most time would be ideal. Vehicles located at households and commercial stores should be considered as an extension of the structure, hence a potential sampling point (both indoor and outdoor).

(5) Air. The number of air samples to be collected will be dependent on the number buildings and structures, as were the wipes. The sample technique that was used for determining the number of wipe samples should be used to determine the number of air samples that are to be collected using Equation 1. In this case though, the population number (N) to be used is the number of structures that were to be wipe sampled. Table 3 details air sampling requirements based on the wipe sampling requirements listed in Table 2.

Table 3. Air Sample Size Determination.

Area	Grid Size (meters)	" (%)	) (unitless)	Structures Wipe Sampled within Zone (%)	Structures Air Sampled within Zone (%) *
Zone A	201	95	0.10	50	25
Zone B	402	95	0.20	20	10
Zone C	805	90	0.20	15	7.5
Zone D	1609	80	0.20	10	5

* - Structures selected for air sampling should be from those which were wipe sampled.

(6) Surface Water. Surface water sites that will be sampled will be determined in the same manner as wipes using Equation (1). Based on these numbers and what zones are involved, some percentage will be sampled. The number of samples to be collected at these sites will be dependent on the size of the site and the type of water it is, lentic or lotic. Each grid that a surface water site extends into will count as 1 site. A river passing through 20 grid areas would be 20 sites. For each lotic water site, samples should be collected downstream this distance equaling approximately 5 times the width of the waterway. This will approximate surface water transportation of CWA away from the deposition area to areas potentially outside the impacted grid area. Table 4 provides examples for water sample site determination and location.

Table 4. Surface Water Site Sample Determination.

Examples	# of Grids Found In (Total Sites)	Type of Water	Potential Number of Samples	Width of Waterway (meters)	Distance Downstream Samples are to be Collected from Each Site (meters)
River	20	lotic	20	305	1524
Stream	5	lotic	5	1.5	7.6
Pond	2	lentic	2	N/A	N/A
Marsh	6	lentic	6	N/A	N/A

(7) Miscellaneous. The number and types of miscellaneous samples will be dependent on a variety of things (terrain, field reports, sensitive populations, crops, etc.) When and where to take these will be dependent on their proximity to the release and location within the sample grid system.

(a) Terrain. Unique terrain features such as gullies, ditches, and valleys which may serve as vapor collection points or conduits for plume passage should be sampled. Field reports which indicate the passage or presence of CWA should be reviewed. Reports coming from outside the sample grid should be immediately investigated to determine whether the grid should be active or incorporated into the grid system itself. This is crucial since the computer model is only a prediction.

(b) Sensitive Populations. Sensitive populations (day care centers, hospitals, schools, etc.) should all be located within and immediately around the IRZ. When these locations are within a grid requiring sampling, these locations should be identified as one of the sample points. Sensitive populations located outside of the activated grids may be considered for additional sampling if located near the buffer zone or further downwind outside of the predicted plume deposition area. In these instances we are purposefully biasing are sampling to those populations with the greatest risk.

(c) Biological. Biological samples (agricultural products, wildlife, etc.) will be collected as needed. Animals which are dead or behaving out of the ordinary and plants which are discolored or wilted should be considered for sampling. The primary purpose of this type of sampling is to clear areas of CWA deposition identify potential ‘hot spots.’ Deposition areas which are identified as commercial agricultural areas will not be sampled with the intention of clearing the material for resell and human/animal consumption. Scheduled sampling efforts may ultimately satisfy this requirement, however, the site manager will not make this determination. Health and safety officials will evaluate the ‘complete’ release event and make the final determination.

d. Sample Collection.

(1) Soil. Soil samples are to collected from within $\pm$100 feet of the grid coordinate. Grid points can be found using an Enhanced Precision Lightweight Global Positioning Satellite (GPS) Receiver (EPLGR). This will allow field personnel to identify sample locations to within $\pm$5 feet. When selecting the specific sample point, the site should be free/devoid of surficial matter such as leaves, twigs, or any other organic matter, open bare ground being ideal. Any organic matter in the sample may adversely affect laboratory analyses. Soil samples are collected using a stainless steel scoop or spatula. Using the scoop or spatula, scrape and collect surface soil to a depth of no more than 1 inch. Place the sample directly in the sample container. Collect a sufficient sample such that there is no head space in the jar. Then , tightly close and label the container. Table 5 lists sample collection requirements. Do not collect and mix the sample prior to placing in the sample jar. Mixing may release CWA from the sample skewing sample results to the low side.

Table 5. Sample Collection Requirements.

Media	Container	Volume Required	Preservation	Maximum Holding Time (days)
Soil	4 oz glass bottle with Teflon™ lined cap	2 x 100 g	4 °C	7
Wipe	40 mL glass bottle with Teflon™ lined cap	2 x 1 Wipe [A]	4 °C	7
Water	100 mL amber glass bottle with Teflon™ lined cap	4 x 100 mL	pH < 2, 4 °C	ASAP
Air	Air Bubbler	TBD	4 °C	ASAP
Biological	CWA Impermeable Plastic Bag	n/a	< 0 °C	14

A - Collection solvent: Methanol
References 14, 15, and 16.

(2) Wipes. Wipe samples are collected using an acrylic swab soaked with collection solvent (see Table 5). Using tongs, the swab is swiped across a 10 cm by 10 cm area using an up-and-down motion (reference 17). The swab is then swiped across the area using a side-to-side motion and is then placed in a 40-mL vial, sealed, and sent to the laboratory for analysis. The area to be swiped is typically measured using a pre-cut template of the required sample dimensions. Suggested wipe sampling points are listed in Table 6. Wipe samples should not be collected from an area that was sampled previously. If multiple samples are required from one location, these should be collected from adjacent areas.

Table 6. Suggested Wipe Sample Locations

Locations	
Automobile Windshields	
Window Panes	
Kitchen/Bathroom Sinks/Bathtubs	
Kitchen/Bathroom Countertops	(Tile Only)
Ventilation Ducts/Outlets	

(3) Air. Air samples will be collected by trained, certified technicians. The methods to be used are prescribed in DA PAM 385-61 (reference 5).

(4) Surface Water. There are two types of surface water - lentic (slow moving) and lotic (fast moving). As such, there are two separate collection procedures. Surface water samples may be collected in two forms. Obviously, water can be the sample media collected. The other means for evaluating surface water would be the collection of sediment samples.

(a) Lentic Sites. Water samples collected at lentic water sites should be collected from shallow water areas located at the edges of the site. The sample container should be lowered into the water to allow water to flow into the sample container with as little disruption to the site as possible. The shallow areas of the site should be less turbulent (convection currents) then the deeper areas of the site and may extend the half life ($t_{1/2}$) of the CWA. With less mixing, CWA and their breakdown components may stratify concentrating in various layers. By sampling at the edge, we should be sampling the most accessible and likely layer.

(b) Lotic Sites. For lotic sites, water or sediment samples can be collected. Water samples should be collected in the same manner as lentic water samples, at shallow, 'calm' locations along the water. In lieu of water, sediment samples can be collected. These should be collected at the same locations as would a water sample. Using a scoop, sediment from along the edge of the water line should be collected to a depth of no more than 1 inch until sufficient sample has been collected to fill the sample container. Sediment samples should not be mixed prior to filling the sample container.

(5) Miscellaneous. Miscellaneous samples will probably fall under one of the above categories for collection purposes. Some exceptions might be snow and biological materials such as leaves, insects, fish, etc. Though these types of samples may be desirable for certain assessment purposes, be aware that analytical capabilities may be particularly limited. In addition - there are no standard criteria/methododolgies for assessing the 'significance' of risk to or from of these types of 'special media' and if attainable -these results will generally require a very detailed risk assessment. Such samples should only be taken if deemed absolutely necessary (to answer key public health concerns).

(a) Biological. Sampling for biological material (e.g. birds, insects, small mammals, leafy plants) will for the most part simply be collecting the specimen and placing it within a sample container. Preferably, samples are collected using tongs or some other grabbing device and placed in a CWA impermeable bag. The bag should be sealed with a minimal amount of headspace and then immediately iced to prevent any further degradation due to biological or microbial activities.

(b) Snow. For some stockpile sites, there is a strong possibility that the CAI may occur when snow is present or being deposited on the surface. In this event, soil and wipe sampling may be rendered unnecessary since the surfaces that would normally be sampled would be covered. Is this event, rather than collect soil or wipe samples, snow samples are to be collected in their place. If the CAI occurs during a snow event with no previous snow deposition, snow cores with a 3 inch diameter should be collected. If the depth of the snow is insufficient, additional cores should be collected until the sample container is full. If snow was present prior to the CAI, collect snow from the top 2 inches (or less) until the sample container is full.

e. Extreme Climatic Conditions. In the event of an CAI which is caused by an extreme climatic condition such as a tornado, hurricane, rainstorm, etc., sampling activities will initially be limited to Zone A of the grid system. If field reports indicate the presence of CWA outside of Zone A, and depending on the number of field reports, those grids can either be incorporated into the sampling scheme or, if sufficient field reports are confirmed, Zone B become activated. Models for air dispersion and soil deposition will not be able to accurately model these events. The sampling approach for these types of CAI will be a wait and see, with limited sampling unless until otherwise indicated.

f. Collection Priorities. The priority in which samples are collected and analyzed for CWA presence will be dictated by human health considerations (emergency evacuation), CWA confirmation, and area reentry. Table 7 lists the recommended priority. Initially, the boundaries of release should be confirmed followed by the clearing of emergency evacuation routes. This should then be followed with the sampling of confirmed/suspect field reports of CWA outside the grid boundary. From this point, sampling should be conducted such that the grid collapses upon itself. Identified 'hot spots' will be left for further evaluation upon the completion of the recovery sampling efforts. This sequence of priorities will allow for the most expedient 'clearing' of zones for general reentry.

Table 7. Recommended Sample Collection Priority.

Priority
Deposition Area Perimeter (Outer Grid Vertices)
Emergency Evacuation Routes/Areas (Required samples, all matrices)
Field Reports of CWA Outside Initial Active Area
Wipes
Deposition Area Interior (Inner Grid Points)
Air Samples
Surface Water
Wastes

Note: The priority in which miscellaneous samples will be collected will be dependent on the matrix and location of the site to be sampled. The site manager will prioritize these samples.

g. <u>Field Quality Assurance/Quality Control (QA/QC) Procedures</u>. Field splits and duplicates should be taken to ensure sampling and laboratory quality control. These QA/QC samples should be collected in addition to the scheduled samples. The number of collected should equate to approximately 7 percent of the total number samples collected for both splits and duplicates. Field splits and duplicates will not be collected for biological samples such as animal carcasses. These should be further defined within the quality assurance project plan.

(1) Field Splits. Split samples are collected by dividing the sample in half. These halves are then submitted as two distinct analyses. Split samples results can be used to evaluate sample collection technique. Note: Split samples are not collected for wipe samples.

(2) Field Duplicates. Duplicate samples are collected by sampling two locations which are immediately adjacent to one another. Duplicate sample results can be used to evaluate the homogeneity/distribution of contaminants within the given media.

h. <u>Data Quality Objectives (DQO)</u>. The DQO define whether sampling efforts have adequately identified and addressed necessary questions and concerns. In essence, the primary goal of sampling is to determine whether or not CWA/breakdown components are present at a concentration of predetermined significance ('significance' meaning of potential health concern). This 'significance' is based on the statistical parameters and degree of 'confidence' described above. The statistical DQOs should be determined and documented in the RSAP before sampling is implemented. Once QA/QC on both field and laboratory activities have been evaluated, any suspect analytical data will be evaluated on a case by case basis in order to determine whether the data should be qualified, the original samples should be reanalyzed, or ,in some cases, the site re-sampled. Once all 'valid' data is identified, the DQOs described in here and in the RSAP must be 'checked' to ensure that enough sample data was still available to achieve the desires confidence level. In essence, this will be a pass/fail excercise. Data from each grid will be evaluated for QA/QC performance and compared against current health-based screening levels (HBESL) (reference 7). Grid areas which are 'positive' (results above HBESLs) or questionable data will considered 'hot spots', remain active and quarantined for further evaluation. Results for grid areas where all analytical data fall below HBESL and and pass QA/QC review will be reviewed areas with sound data will be forwarded to the site manager for review and consideration for deactivation of the grid.

10. ANAYTICAL/LABORATORY REQUIREMENTS.

a. Analytical Methodologies. Analytical laboratories will not be directed to which method(s) they should use. Rather, detection limit goals for CWA and associated breakdown compounds will be given. Table 8 lists the detection limit goals. These are based on the most conservative HBESLs established for chemical agents (reference 7). Tables 9 and 10 identify the key CWA breakdown components associated with each chemical agent and the associated detection limit goals for those breakdown compounds (also based on information and HBESLs described in reference 19). In the likely event that the selected laboratories do not have methods in place for the various matrices, an evaluation of the 'best' methods available (to include assessing alternative laboratory services) must be performed. To facilitate this process, the U.S. Army is currently compiling a "Compendium of Analytical Methods for Military Chemical Agents and Associated Compounds" (reference 18). When completed, laboratories/activities which need to identify procedures for specific CWA and/or breakdown components can search the compendium in order to preclude developing an already existing method or ascertain whether a method exists as all. In certain cases, it may be identified that these very conservative 'goals' cannot be met by any attainable laboratory support. In other cases, very limited support (only a few samples) may be reasonably analyzed to such levels. This is particularly important to identify before a CAI occurs so that appropriate negotiations and decisions can occur regarding 'acceptable' goals and numbers of samples.

Table 8. Analytical Detection Limits -Goals for Stockpile CWA in Various Environmental Media.

Media	GB	VX	HD	L	Notes
Soil/Sediment/Biologicals (mg/kg)	0.75	0.025	0.15	3.8	
Water (: g/L)	0.36	0.011	$2.1x10^{-5}$	1.8	
Air (mg/m^3)	$1.5x10^{-6}$	$1.5x10^{-6}$	$5x10^{-5}$	0.0015	
Wipe (: $g/100cm^2$)	0.075	0.0022	$1.7x10^{-4}$	0.37	

References 7 and 19.

Table 9. Selected Key Breakdown Products of Chemical Agents.

Abbreviation	Name	Parent Compound
TDG	Thiodiglycol	Sulfur Mustard
MPA	Methylphosphonic Acid	GB, VX
EMPA	Ethyl Methylphosphonic Acid	VX
IMPA	Isopropyl Methylphosphonic Acid	GB
EA2192	S-(2-diisopropylaminoethyl)methylphosphonic Acid	VX
Lewisite Oxide	2-Chlorovinyl Arsenous Oxide	Lewisite
Arsenic	Inorganic Arsenic	Lewisite

Notes: Compounds selection was determined using reference 20.

Table 10. Analytical Detection Limits Goals for Selected - Breakdown Components of CWA in Various Environmental Media.

Media	TDG	MPA	EMPA	IMPA	EA2192	Lewisite Oxide	Arsenic
Soil/Sediment/ Biological (mg/kg)	50 [A]	500 [A]	50 [A]	200 [A]	0.01 [B]	7.7 [C]	0.38 [D]
Water (: g/L)	10 [A]	100 [A]	10 [A]	50 [A]	0.010 [B]	3.7 [C]	190 [E]
Air (mg/m^3)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Wipe (: $g/100cm^2$)	10 [A]	100 [A]	10 [A]	50 [A]	0.05 [B]	0.75 [C]	in development

A - reference 15
B - reference 16
C - reference 7
D - reference 21
E - reference 22

b. Quality Assurance/Quality Control. Quality Assurance and quality control are a means of monitoring and assessing the quality of the data These assess the ability of the laboratory to perform prescribed methodologies and whether the methods themselves accurately measure contaminant concentrations in the specific environmental media (soil, wipes, air, surface water, biological, snow). By assessing the laboratories and methodologies they use, the data that is generated will be easier to defend if challenged in any way. The laboratories which are contacted in preparation of the sampling plan should include their Quality Assurance Manual (QAM) or Quality Assurance Project Plan (QAPjP) as an appendix in the sampling plan. The QAPjP should detail the Quality Assurance Program within the laboratory. Table 11 lists some of the specific components of the program. Details for their preparation can be found in the EPA Requirements for “Quality Assurance Project Plans” (reference 23). A second/independent laboratory should be used to analyze field duplicate samples at a rate of 5% of the total samples taken. The sample points selected for collection of field duplicates should be determined randomly. The QAPjP will define the QA/QC parameters used for assessing the quality of data generated from a single lab and for comparing data between multiple laboratories for precision, accuracy, representativeness, completeness, and comparability (PARCC). Before used in a site evaluation, analytical data will first be assessed using the PARCCs listed within the QAPjP. This will establish the validity of the data and determine whether or not any of the data is suspect.

Table 11. Components of a Quality Assurance Manual/Program.

QAM/QAPjP Sections
Quality Assurance Policy
Data Quality Objectives for Each Method
Chain-of-Custody (CoC) Procedures
Preventive Maintenance Schedules/Documentation
Data Management (reduction, validation, review, reports)
Instrument Calibration Procedures
Corrective Action Procedures
Performance/System Audits
PARCC - precision, accuracy, representativeness, completeness, & comparability
Quality Control Procedures

11. FIELD ACTIVITIES - SPECIFIC PROCEDURES AND RESPONSIBILITIES

a. Schedule. The time lines for execution of a sampling plan will be entirely dependent on the size of the CAI, location of the stockpile site, and the number of field and laboratory personnel utilized. Essentially, sites located in remote areas will require fewer samples to be collected primarily due to the lower population density in those areas. This results in fewer wipe and air samples. More populated areas will require a higher number of wipes and air samples. Ideally, an RSAP for a 'small' release could be implemented and executed in several days, a 'large' release in one week. Again, time lines will vary due to population densities. The bottleneck for any CAI operation will be the laboratory. Environmental samples can only be processed (extracted and analyzed) so fast. This is due to the time required for extracting the CWA/byproducts from the matrix, the time required to analyze the extracts, and to the maintenance and quality control procedures needed to ensure accurate analyses. Hence, sampling activities may be completed long before all analyses are complete. Sample collection prioritization should include prioritization of analyses in order to facilitate the deactivation of grid areas.

b. Responsibilities. The site manager and field technicians will be responsible for placing the samples in the sample containers. The site manager will ensure that the samples are properly labeled, preserved, stored, and shipped to the laboratory. He will also be responsible for ensuring the proper CoC is maintained. The field technician will be responsible for obtaining the samples and decontaminating any nondisposable sampling equipment. The order of sampling will be determined by the site manager as dictated by field reports and sampling priorities as outlined in the Collection Priorities Section.

c. Sample Handling and Management. Field personnel will place all samples for laboratory analyses in containers at the sample site. Labels will be affixed with a sample identification number, date and time sampled, and with the name of the field personnel collecting the sample using an indelible pen. The sample numbering scheme should identify the grid point or grid from which the sample was collected as well as identify the location within the grid from the where the sample was collected (e.g. W0240001, wipe sample number 1 from grid 24). Samples will be placed into coolers filled with ice to maintain a temperature of 4 ± 2 °C. Field personnel will record appropriate field observations in a permanently bound field notebook. All samples will be shipped directly to the laboratories for analyses.

d. Record Keeping. Detailed notes will be maintained by the site manager and field technicians. This will include sample locations (as determined by the EPLGR), sample identification number, date and time collected as well as any other relevant observations (i.e. dead animals, discoloration, residue). An inventory of samples should accompany each cooler of samples delivered to the laboratory with any other appropriate instructions.

e. Chain-of-Custody. Chain-of-Custody starts in the field. Once samples are collected, a detailed paper trail will be established documenting who and when individuals who had possession or controlled access to the samples. This will be maintained from the time of collection until all analyses have been completed. An CoC program is necessary to control access to the samples in order to ensure that samples are not tampered with by persons unknown and that the samples are properly stored and handled during the recovery operation. A CoC standing operating procedure should be written and included in the QAPjP.

f. Resources. In order to implement the RSAP effectively, necessary resources will need be coordinated ahead of time. The QAPjP will identify the laboratory requirements for the anticipated sample load and expected turn-around-times (TAT). In order to meet the TAT, samples will need to be collected quickly and efficiently. Sample personnel and equipment will need to programed. The time needed to collect one sample will be approximately 15-30 minutes (10-15 minutes for collection:10-15 minutes for locating and identifying the sample point). Based on the likely scenario and approximate collection time, the number of sample teams and supporting equipment needed can be programed.

g. Decontamination Procedures. One or more excursion zones should be set up for persons exiting active cells. Entry and exit of active areas should be strictly controlled. At these exit points, a decontamination line should be established, whereby, all persons exiting the active area are thoroughly decontaminated using standard U.S. Army procedures as detailed in the site specific Site Safety and Health Plan. Personnel who collect samples may, as a result of sampling activities, become contaminated themselves. Equipment used to collect samples may also be contaminated due to having been in direct contact with the sample. All sampling equipment and personal protective equipment (PPE) used in the collection of samples should be collected and turned over to the U.S. Army for proper treatment and/or disposal. Personnel should not attempt self decontamination while in the field.

h. Waste Management and Disposal. All materials used to collect samples should be disposable, if possible. This will include both PPE and sample collection equipment. This will minimize the need for decontamination of items and significantly reduce the amount of decontamination solution and rinsate that is generated. Once used, all PPE and disposable sampling equipment will be stored in agent-tight containers. If after all sample analyses have been complete none of the samples indicate the presence of CWA, all wastes generated during collection activities can disposed of in a subtitle D landfill or as general nonhazardous waste Wastes associated with samples which test positive for the presence of CWA will need to be will be turned over to U.S. Army officials for proper disposal.

12. DATA EVALUATION. Once the quality and acceptability of the data have been determined, the data is evaluated against pre-established chemical agent HBESLs (reference 7). Screening levels or Preliminary Remediation Goals (PRGs) have also established for various industrial contaminants to including arsenic, in soil (references 21) and water (reference 22). Through use of the same EPA health risk modeling methodologies and currently DA-Office of the Surgeon General approved toxicologic reference doses (reference 24), the DA [has] established HBESLs for chemical agents and key breakdown products of concern. The HBESLs are established for various types of situations such as contamination in a residential area (where children may be exposed) or in an area where only adult workers may be exposed. Ideally, site-specific health risk assessments should be used to determine the actual degree of significant health impacts. However, use of the HBESLs and associated guidance provided in reference 7 will facilitate initial baseline screening determinations regarding action or no-further action (to include detailed assessment, management controls, and /or remedial efforts). The site-evaluation may initially focus on use of the conservative numbers presented in reference 7 but consultation with the USACHPPM, Environmental Health Risk Assessment (HRA) and Risk Communication Program is required (reference 25), commercial 410-671-2953 (DSN 584-2953) to ensure appropriateness of the HRA determinations.

13. OTHER PROJECT MANAGEMENT REQUUIREMENTS.

a. <u>Organizational Roles and Coordination</u>. Should changes be necessary to the RSAP once field sampling activities have been initiated a process of change should be identified, particularly identifying who has what decision authorities, etc. For example, Table 7 details a recommended order for prioritizing sample and analyses activities. Events in the field or specific stockpile site characteristics may dictate that the specific samples be processed outside of the given recommendation. On these occasions, the site manager has the sole authority for altering or implementing an alternate prioritization scheme

b. <u>Supplies</u>. At a minimum, the quantity of sampling and PPE supplies maintained should be sufficient to supply a response to the most likely scenarios. If a CAI were to occur which would require additional supplies, these will be obtained from one or more of the other stockpile sites. Some of the items which will be required have expiration dates, these typically being chemicals. Therefore, those items should be inspected and replaced when necessary. Otherwise, expired supplies may adversely impact analytical results possibly resulting in false positive/negatives necessitating that sites be resampled.

c. <u>Site Safety and Health Plan</u>. A Site Safety and Health Plan (SSHP) should be prepared in conjunction with the RSAP. The SSHP will delineate the responsibilites of individuals present during the execution of the RSAP and will also identify all potential hazards (biological, chemical, and physical) associated with the execution of the RSAP. Other items which should be addressed within the SSHP are personnel protective equipment, decontamination procedures, personnel training, site control measures, and emergency procedures (rendering first aid, who to notify, etc.).

d. Data Interpretation and Release. All analytical data and related conclusions and recommendation will only be released with the approval of the site manager. Based on the information generated from the sampling activities, the site manager will determine when an active grid area can be deactivated. And if necessary, designate which active grids will be quarantined until a more site specific health risk assessment can be completed. Current HBESL will be used to determine which active grids are to be deactivated or quarantined. Areas which are quarantined will be evaluated for the level of reentry which will be allowed.

e. Decision Documentation. A detailed account of information and specific actions and decisions should be maintained throughout the entire recovery operation. This documentation will detail the why's and when's of decisions made. It may be in the format of a continuously updated document or a compilation of notes, memos, etc. This should include how the field reports are handled, how the various active grid areas are deactivated/quarantined, and sample prioritization. This will facilitate any after-action review board investigations/inquiries that will follow any CAI event and serve to improve the process in the unlikely event of additional CAIs. The site manager maintains the sole responsibility for preparing the required documentation.

f. Risk Communication. Risk communication will be vital to keeping the public informed of the progress of the recovery efforts as well as in explaining how or why certain approaches were taken with regards to sampling. The Installation Commander will ultimately be responsible for keeping the public informed. This should include discussion on why samples were collected at specific sites and not others, how models work, HBESLs and what they mean, and how active, quarantined, and deactivated grid areas are defined. Specific assistance on training and consultative assistance on Risk Communication can be acquired by contacting the USACHPPM Environmental HRA and Risk Communication Program (commercial 410-671-2953).

SECTION III

1. EXAMPLE SITE INCIDENT AND RSAP INFORMATION

a. Introduction. The release scenario detailed in the 'Pine Bluff CSEPP Exercise 1997' (reference 6) will be used as an example in the demonstration of the use of the protocol. In this scenario, 2,232 VX, M55 rockets are consumed in an igloo fire over the course of several hours. All agent is either consumed or released. The plume from the fire/agent release moves south. This scenario has been described as a 'worst of the worst' rather than as a likely scenario.

b. Site Description. In this scenario, the D2PC model (reference 9) indicated the VX plume traveled south of the installation for over of 30 miles. The GapCap model determined that VX deposition occurred over an area extending several miles. The deposition area impacted IRZ zones A and H. The outskirts of the town of Whitehall fall within the deposition area. Located within these areas are upwards of 10,000 persons and several thousand building structures. Houses are typically one-story family homes with small business intermixed at various locations. Within these areas are approximately 20 sensitive populations (schools, hospitals, day care facilities, etc.). There are also approximately 15 water locations within the deposition area. The largest of these measuring about 61 m by 152 m. The entire area is moderately covered with ground vegetation and trees. There is one major stream (Caney Bayou) whose course passes through the deposition area. The Arkansas River and several small lakes (Tulley and Yellow) are located to the east of Pine Bluff Arsenal, but are located outside the modeled deposition area. The lakes are situated on a bluff overlooking the Arkansas River flood plain. There are no major ravines or valleys which would significantly alter or direct wind flow.

c. Sample Summary. Figure 4 depicts the grid areas which would be considered active based on the above scenario. Figures 5-8 demonstrates the process on how the process might evolve as sampling/analysis progressed. Figure 5 shows the activated grids without the plume. As time progresses, outer grids are deactivated effectively beginning the collapse of the 'bubble" (Figure 6). Also displayed are activated grids outside the immediately impacted area. Field reports indicated possible CWA passage warranted activation and hence sampling of these areas. Figure 7 displays further collapse of the bubble. Finally, all activated grid areas have been sampled leaving behind only those areas ('hot spots') which yielded analytical results above the screening guidelines (Figure 8). Table 13 lists the approximate number of wipe, air, water, and miscellaneous samples that are to be collected in each of the four zones. The number of soil samples was determined by roughly overlying the grid with the modeled deposition area. The number of grid vertices within the deposition area and grid vertices located within 805 meters of the deposition area were counted. The number of wipe samples was determined using equation (1) and 1990 census data for IRZ areas A and H. The number of households from these given IRZ areas were determined using an estimate of the total areas of A and H which fell within the deposition and buffer zones. Air samples were determined by simply taking 50 % of the total number of buildings/structures which were to be sampled. Water and sediment sites were determined by reviewing U.S. Geographical Survey (USGS) maps for water features located within the deposition and buffer zones. The number of miscellaneous samples was merely an estimate. A more thorough review where the number of buildings/structures and water locations are identified for each specific grid or zone would generate more accurate numbers.

Table 13. Approximate Number of Environmental Samples per Zone.

Zone	Soil	Wipes	Air	Water	Miscellaneous
A	61	20	5	3	25 Total for All Zones
B	28	50	13	3	
C	21	102	26	3	
D	24	414	104	3	
Total	134	586	148	12	25

Note: All sensitive populations located within the grid areas would be wipe sampled. Additional wipe samples could be collected at sensitive population locations in non-impacted areas via miscellaneous sampling.

2. IMPLEMENTATION. The individual CSEPP stockpile sites will be responsible for several items within this protocol necessary to transform it into a complete Sampling and Analysis Plan SAP). The estimated time for completion of the RSAP is 9 months. Once completed, each stockpile site should seek approval of the RSAP and QAPjP from the State and Regional EPA offices. The RSAP and QAPjP should be reviewed and updated on a yearly basis in order to reflect changes in the local communities, CWA maintained, analytical methodology advances, and changes with the HBESLs.

a. Scenarios. 'Likely' scenarios will need to be developed to facilitate sample supply acquisition and laboratory selection (section 2). Using these scenarios, recovery operation teams will be better prepared for what to expect with regards to sampling activities. The grids which would be activated under the mostly likely scenarios should be reviewed in order to determine the number of soil, wipe, air, and water samples that could be potentially collected. This will require a thorough count of the building/structure and water locations within the likely scenario grid areas. These will provide a basis from which an estimate on the number of samples that will be collected and hence the amount sampling supples that should be maintained. Estimated time to complete: 1 month.

b. Topography. Distinct geological or surface features which may impact or direct the flow of plumes should be identified (mountain ranges, hills, canyons, forests, cities, etc.) (Section 6.b). This would include identifying surface water features. These should be restricted to rivers, major streams, reservoirs, lakes, commercial activities, and recreational points. These points need to be identified in order to determine which grid areas contain surface water locations. Geological and surface features are identified as possible miscellaneous sample locations. Estimated time to complete: 1 month.

c. Grid Overlay. Using the recommended grid sizes or site specific preferences as determined by the each CSEPP working group, the IRZ will need to be overlaid with a grid (section 9.c). As stated, the sizes of the grid used will determine the level of confidence for detecting/finding a deposition area of an unknown size. The model used to predict both the plume and deposition may change in the future. Use of these should not affect the use of a grid overlay. Future models may predict plumes and deposition patterns unlike the 'cigar' shaped predictions illustrated here. Rather, pockets of grid areas may be activated based on these more 'accurate' models. Estimated time to complete: 1 month.

d. Buildings. The most recent census should be used to approximate the number of buildings/structures located within the grid areas (section 8.d.2). Known new construction of special buildings such as schools, day care facilities, and retirement communities should also be included. These numbers will facilitate recovery operations for determining the number of samples to take per grid area, if ever required. These will also to serve to give a better estimate of the amount of sampling supplies required to have on hand and what capabilities the laboratory will need to maintain. Estimated time to complete: 2 months.

e. Laboratory. The laboratories which will be conducting the analyses will need to be determined (section 8.h). The selection of a laboratory should be dependent on their being able to handle the specific samples loads associated with the 'likely scenarios.' It will also be dependent on their ability to perform the necessary methodologies associated with the matrices anticipated and the detection limits goals listed in Tables 8 and 10. Estimated time to complete: 5 months.

f. Quality Assurance Project Plan. The laboratories which are selected in preparation of an CAI should be responsible for the preparation of the QAPjP (section 10.b). The contents of the QAPjP will pertain primarily to laboratory operations and should be prepared in accordance with EPA guidelines. Hence, they will be most familiar with their own operations and procedures. Estimated time to complete: 9 months.

g. Supplies. Sampling supplies will need to be stockpiled in preparation for an CAI (section 13.b). The quantity kept on hand should be sufficient for use with the likely scenarios. In the event that additional supplies are needed in an CAI crisis, supplies should be obtained from one or more of the other stockpile sites. Some of the items which will be required have limited shelf lives and/or may deteriorate over time. Hence, these items should be replaced at frequencies such that these items usable at all times. Estimated time to complete: 5 months.

APPENDIX A

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24. Memorandum, DASG-HS, subject: Interim Chronic Toxicological Criteria for Chemical Warfare Compounds, August 1996.

25. Department of the Army, Pamphlet 40-578, Health Risk Assessment Guidance for Installation Restoration Program and Formerly Used Defense Sites, February 1991.

Additional References:

26. CSEPP Reentry/Restoration Plan Workbook and Sourcebook Appendices, DRAFT, June 1994

APPENDIX B

Figures

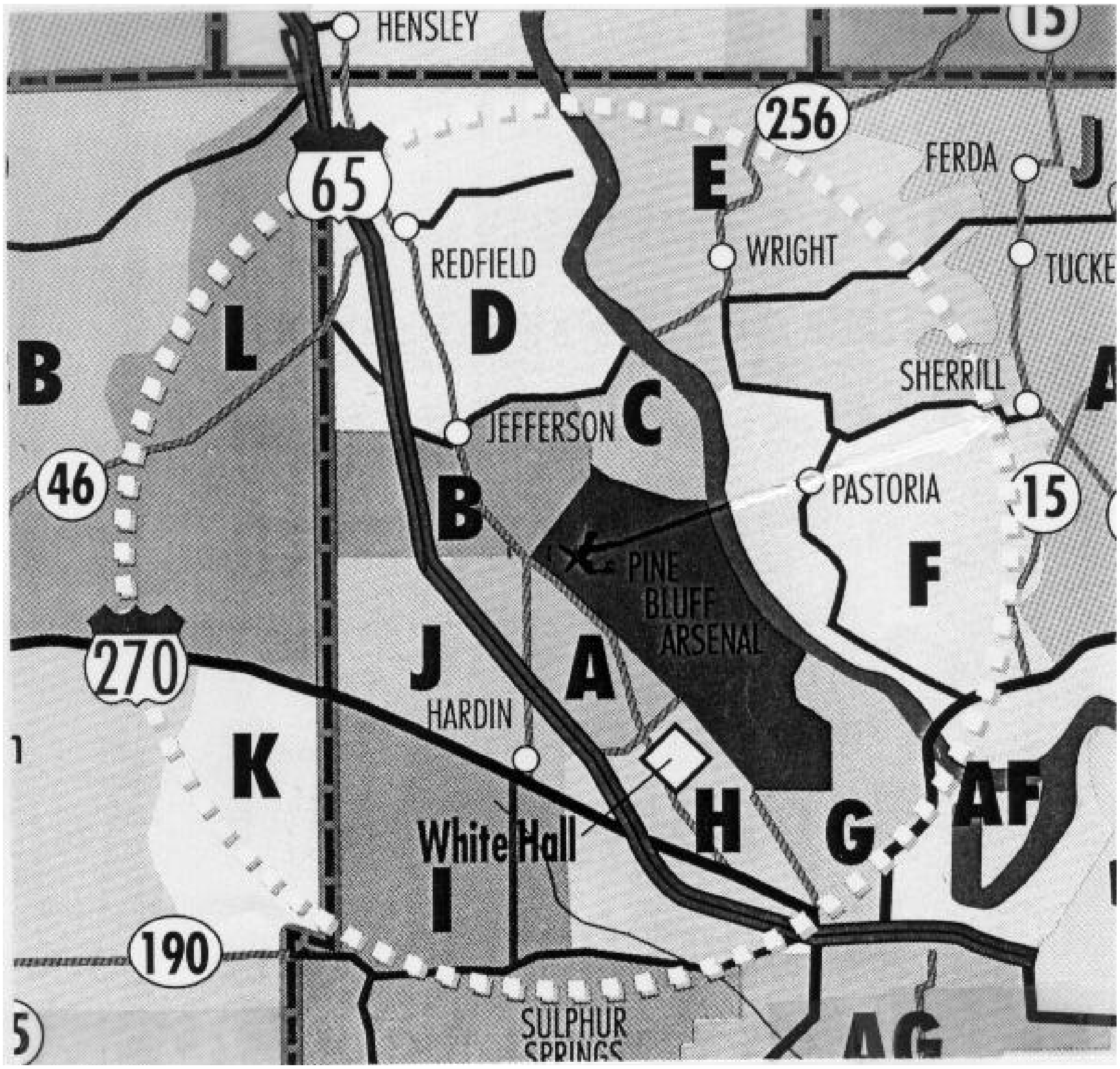

Figure 2. Immediate Response Zone.

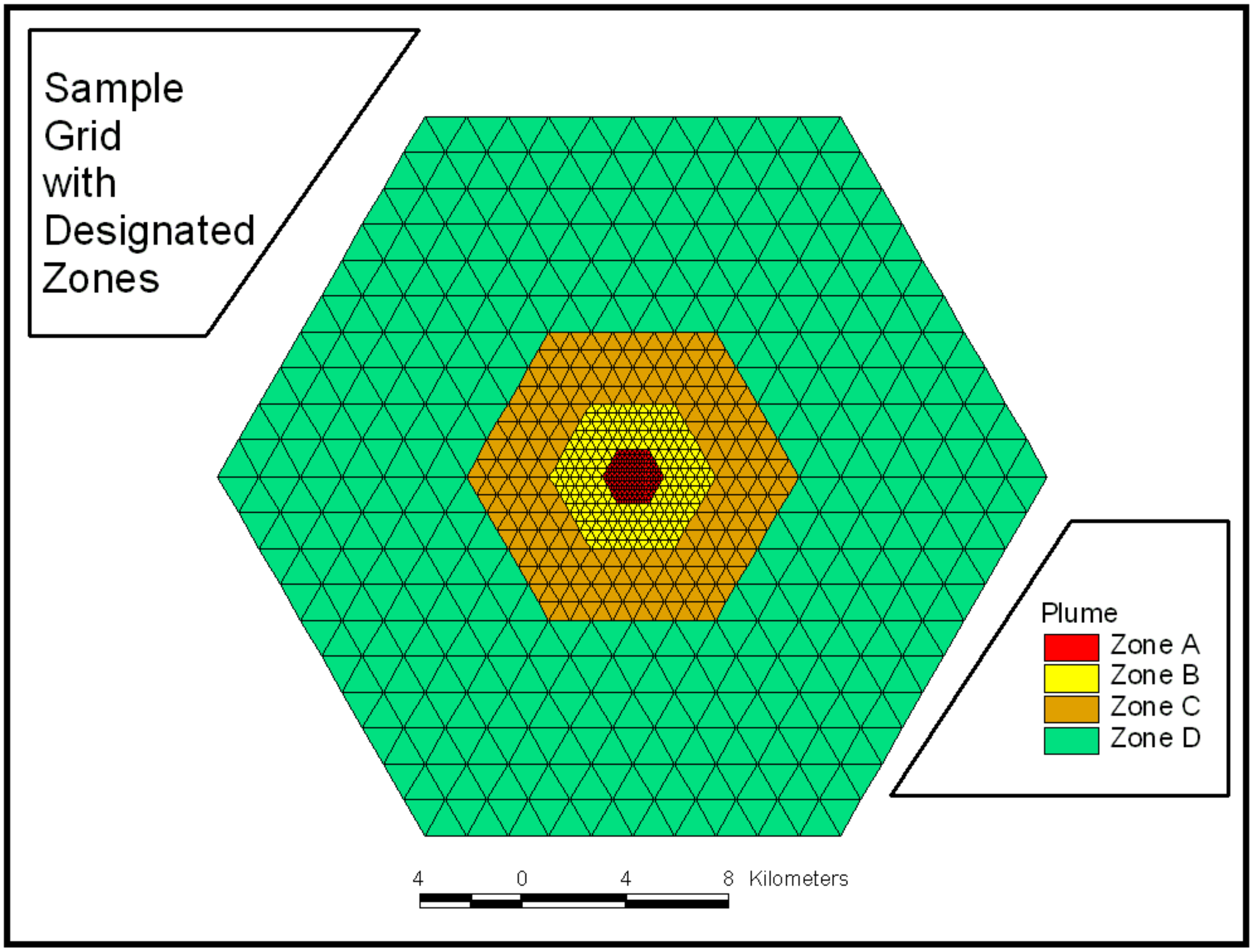

Figure 3. Grid System.

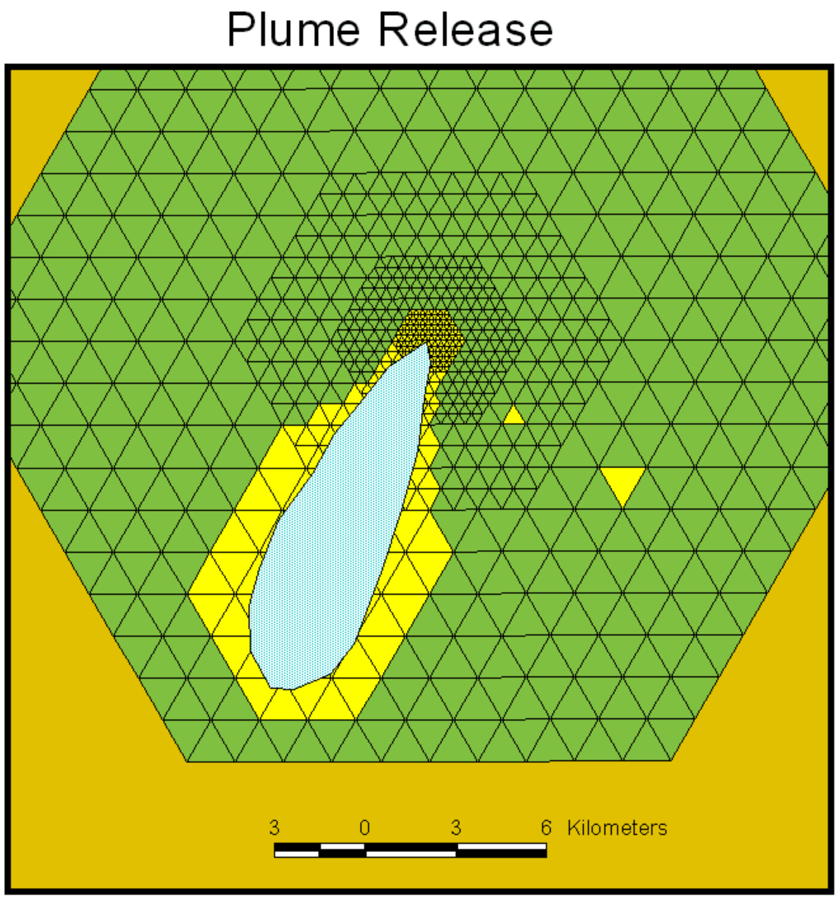

Figure 4. Initial Plume with Activated Grids

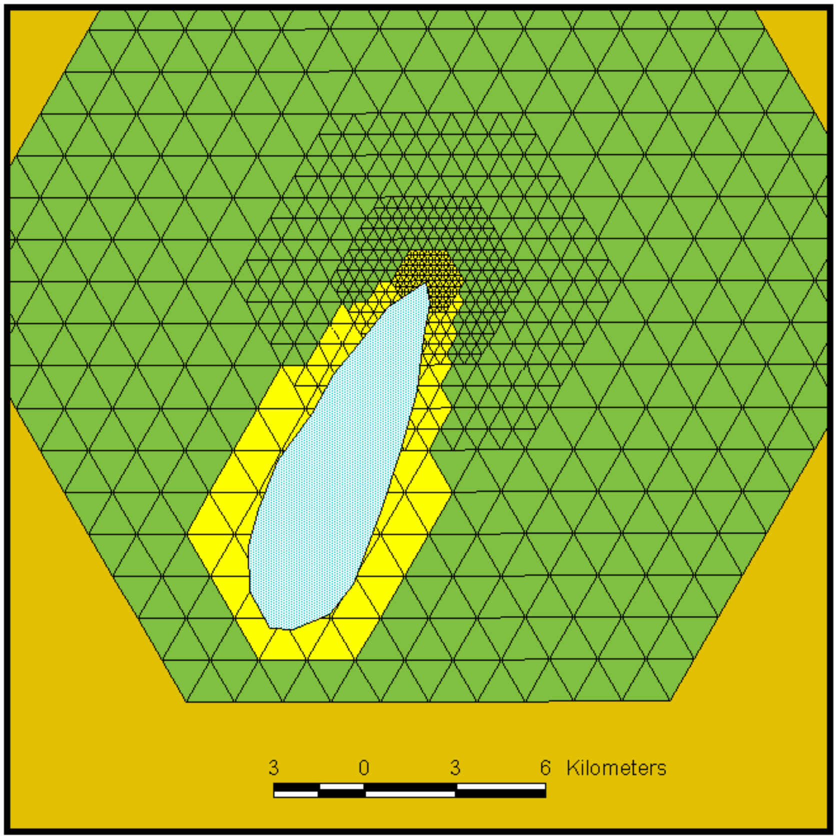

Figure 5. Activated Grids.

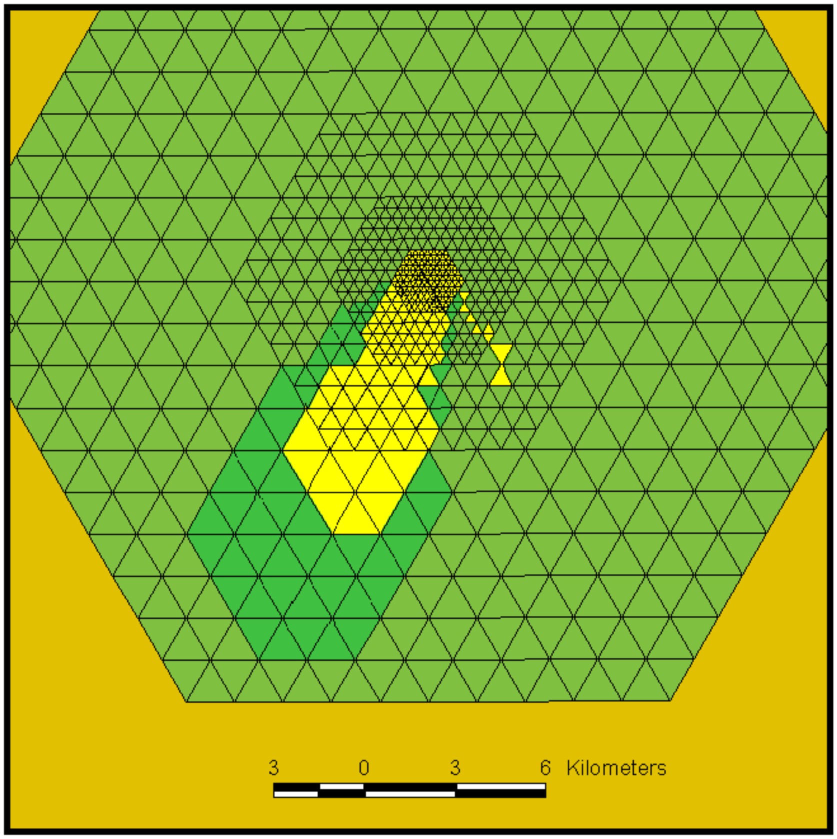

Figure 6. Collapsing of Activated Grids with Additional Activated Grids due to Field Reports.

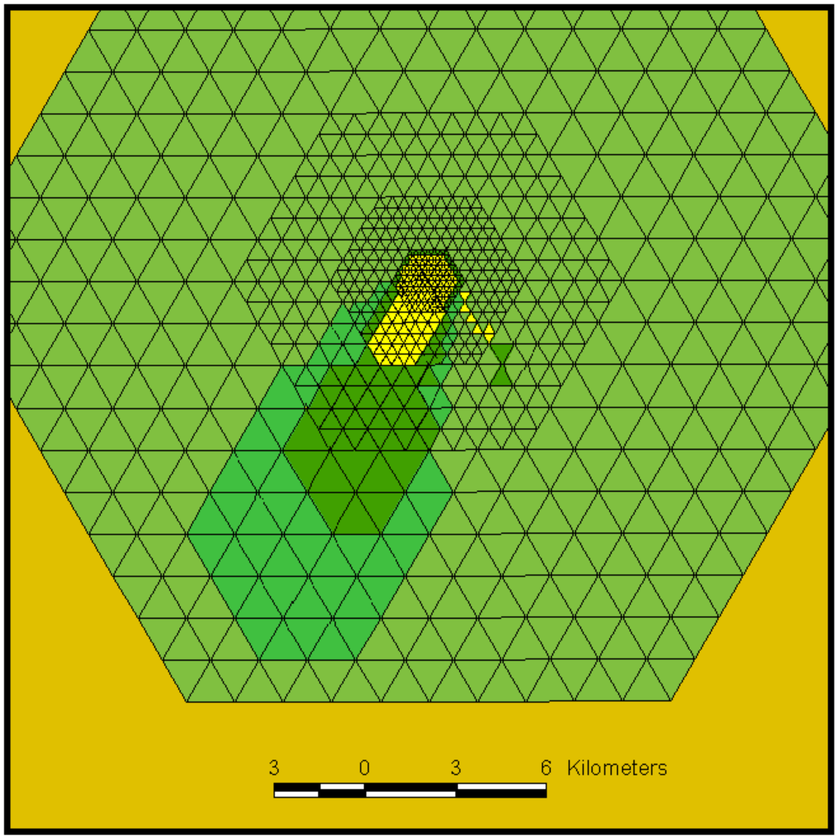

Figure 7. Further Deactivation of Grids.

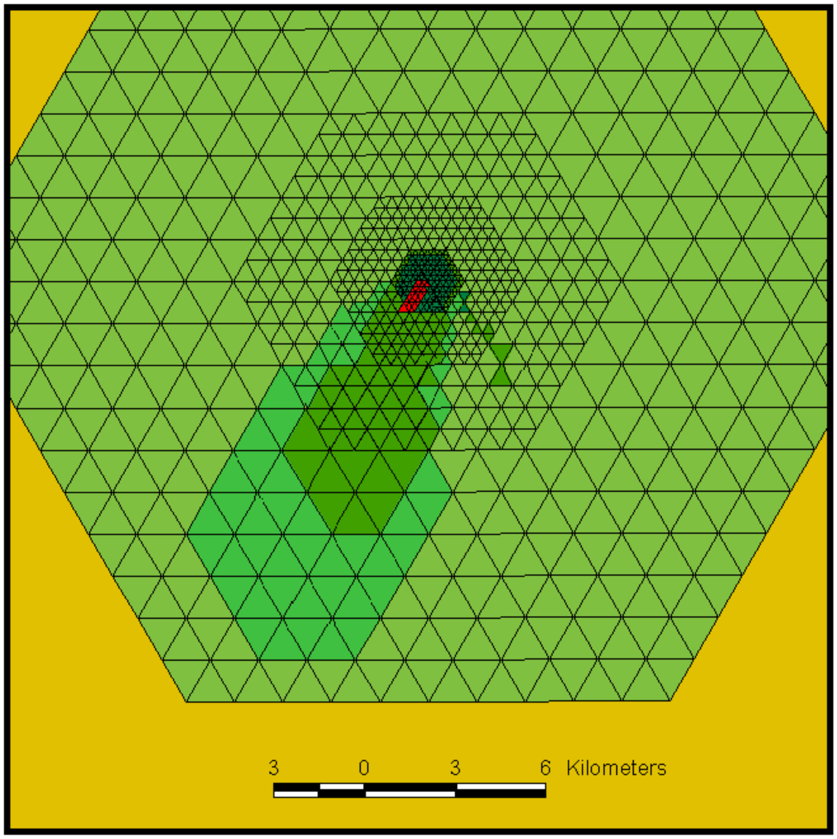

Figure 8. Sampling Complete with Quarantined Grids Remaining.

Sample Grid over Pine Bluff, AR

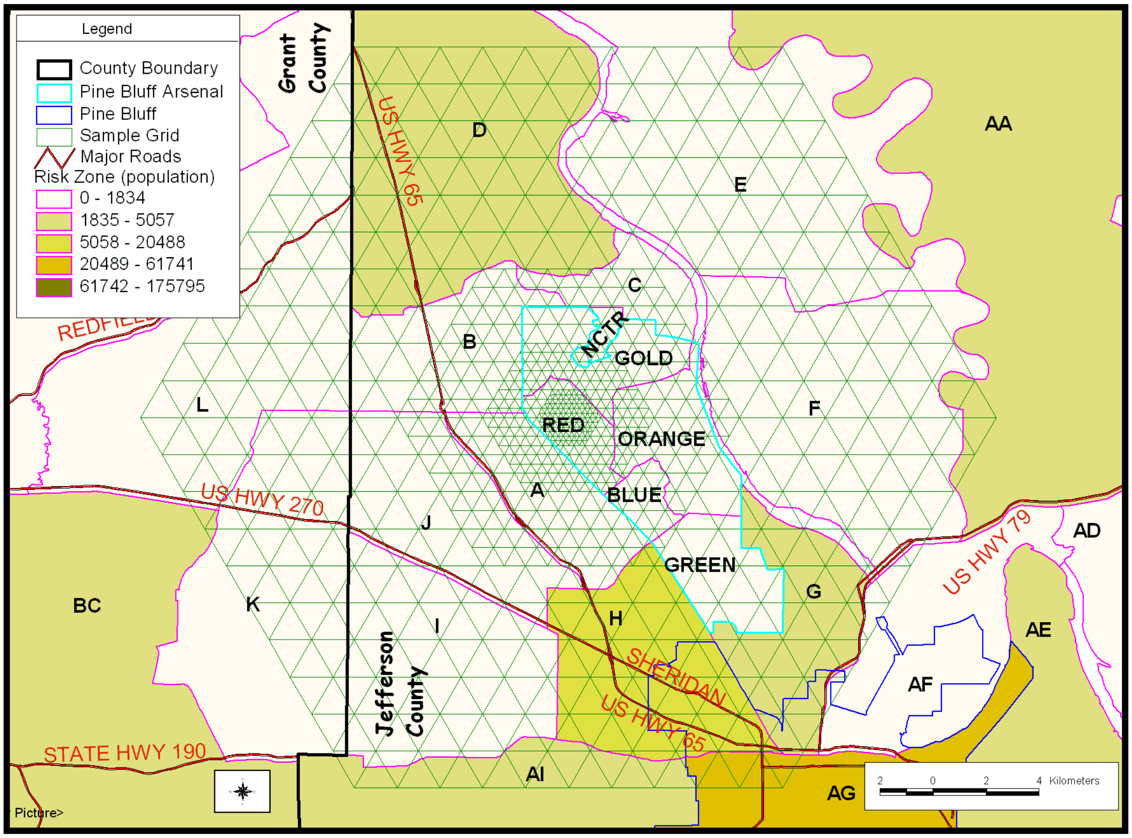

Figure 9. Grid Overlay on Scale Map.

Appendix B
Acronyms

Acronym	
APR	Air Purifying Respirator
CAI	Chemical Accident/Incident
CDC	Centers for Disease Control
CFR	Code of Federal Regulations
CHPPM	Center for Health Promotion and Preventative Medicine
CSEPP	Chemical Stockpile Emergency Preparedness Program
CWA	Chemical Warfare Agent
EMS	Emergency Medical Services
FEMA	Federal Emergency Management Agency
GPL	General Population Limit
HAZMAT	Hazardous Materials
IDLH	Immediately Dangerous to Life and Health
IPT	Integrated Product Team
LEPC	Local Emergency Planning Committee
LOQ	Limit of Quantification
MCE	Maximum Credible Event
MSDS	Material Safety Data Sheets
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Agency
PAPR	Powered Air Purifying Respirator
PPB	Parts per Billion
PPE	Personal Protective Equipment
PPM	Parts per Million
PPT	Parts per Trillion
TWA	Time Weighted Average

APPENDIX C

MONITORING EQUIPMENT

UNCLASSIFIED

Contract No. SPO900-94-D-0002

Task No. 297

CSEPP Chemical Detection Equipment Assessment Volume 1

To

U.S. Army Chemical and Biological Defense Command
Chemical Stockpile Emergency Preparedness Program

April 27, 1998

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UNCLASSIFIED

DISCLAIMER

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EXECUTIVE SUMMARY

The probability of a chemical stockpile event that could affect off-post areas is extremely small. Regardless of this probability, emergency plans and procedures must be established to help minimize the negative impacts associated with such an event. An important component of this preparedness is the capability to detect chemical warfare agents in a timely manner. The purpose of this document is to summarize and assess detection equipment capable of detecting chemical warfare agents that is applicable to CSEPP off-post users.

The equipment reviewed was a representative sample of available items for each of the detection technologies. Information on the various detectors was gathered from product literature and previous Battelle market surveys and assessments. A detector information sheet was developed for each product describing the relevant characteristics. A draft of the detector information sheet was delivered to the respective manufacturer for verification. A final version of the information sheet was developed based upon the manufacturer comments.

Generic criteria were developed to help assess the applicability of the detection equipment to the potential off-post user groups. Criteria addressed the operational, logistical, physical, and special requirements of users. Operational requirements included equipment sensitivity, selectivity, response time, and start-up time. Logistical requirements included ease of operation, maintainability, supportability, and cost. Physical requirements included size, weight, and transportability. Special requirements included regulatory considerations and interface requirements. The generic criteria can then be refined by off-post users to address a specific mission.

To illustrate the assessment process, two potential missions were developed to focus the requirements and subsequently conduct an assessment. The two example missions included off-post decontamination personnel and Traffic Control Point (TCP) personnel. The assessment focuses on the technical aspects of the equipment and does not account for on-site procedures, equipment, or capabilities. Inclusion of these factors could affect the requirements of off-post user groups and the results of the equipment assessment.

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1.0 Introduction

The probability of a chemical stockpile event that could affect off-post areas is extremely small. Regardless of this probability, emergency plans and procedures must be established to help minimize the negative impacts associated with such an event. An important component of this preparedness is the capability to detect chemical warfare agents in a timely manner. The initial emergency assessment and monitoring efforts will be performed by on-site personnel involved with chemical agent facility operations. If off-post zones are affected, local and state officials and citizens could potentially be involved with monitoring. The purpose of this document is to summarize and assess chemical warfare agent (CWA) detection equipment that is applicable to CSEPP off-post users.

The diversity of the off-post environments at each of the eight stockpile locations translates to potentially differing user requirements. The applicability of CWA detection equipment to off-post user groups will be dependent upon the specific requirements of the group and characteristics of the event. Parameters such as detection sensitivity and user skill level will significantly impact the equipment selection process. Identical decisions will not necessarily be made at each stockpile location. Planning decisions should be based however on the same technical information and programmatic criteria.[1] This document provides the necessary technical information to assess CWA detection equipment for CSEPP off-post monitoring.

2.0 Technical Approach

The objective of this study was to summarize and assess the applicability of CWA detection equipment for potential CSEPP off-post users. The equipment reviewed was a representative sample of available items for each of the detection technologies. Information on the various detectors was gathered from product literature and previous Battelle market surveys and assessments. A list of relevant detector characteristics was developed based upon potential CSEPP off-post applications. Informational categories included operational, logistical, physical, and special characteristics. A detector information sheet was then developed for each product describing these characteristics. A draft of the detector information sheet was delivered to the respective manufacturer for verification. A final version of the information sheet was developed based upon the manufacturer comments.

Criteria were next developed to assess the applicability of the detection equipment to the potential off-post user groups. Generic criteria addressed the operational, logistical, physical, and special requirements of potential user groups. The generic criteria can be refined to address the specific requirements of the user group based upon the assumed mission. To illustrate this process, two potential missions were examined. For each mission, specific criteria was developed and the equipment was then assessed based upon this refined criteria. The assessment focused on the technical aspects of the equipment and did not account for on-site procedures, equipment, or capabilities. A list of the detection equipment that met the criteria for each mission was subsequently developed.

[1] Federal Emergency Management Agency and Department of the Army. “Planning Guidance for the Chemical Stockpile Emergency Preparedness Program”. May, 1996.

3.0 Overview of Chemical Warfare Agent Detection Technology

The applicability of CWA detection equipment to off-post user groups will be dependent upon the characteristics of the detection equipment. Numerous technologies are available for the detection of chemical warfare agents and chemical compounds. As technological advances are made, more effective and accurate methods of detection are becoming available at lower costs. Chemical warfare agents can be detected by several means that incorporate these various technologies.

3.1 Point Detectors and Alarms

Point detectors are used to detect chemical agents at the location of the detector, or close to the detector using sample lines. It is also possible to place point detectors at remote locations and network them to a centralized location for monitoring and/or data acquisition. When used in the normal configuration (Non-Remote), if the point detectors are sensitive and the concentration of chemical agent is below a lethal level during short duration exposures, point detectors can provide sufficient warning for protective measures to be taken. If the concentration of chemical agent is high enough to be immediately life threatening, however, point detectors may not provide sufficient time to take protective measures. The following subsections describe the technologies typically associated with point detection.

3.1.1 Ionization/Ion Mobility Spectrometry (IMS)

Ion separation of gaseous species can be achieved at atmospheric pressure, which makes IMS a feasible technology. Using proton transfer reactions, charge transfer, dissociative charge transfer, or negative ion reactions such as ion transfer nearly all chemical classes can be ionized.

IMS requires a vapor or gas sample for analysis, therefore liquid samples must first be volatilized. The gaseous sample is drawn into a reaction chamber at atmospheric pressure were a radioactive source, generally Ni^{63} (Nickel 63) or Am^{241} (Americium 241), ionizes the molecules present in the sample. The ionized air sample, including any ionized chemical agent, is then injected into a closed drift tube through a shutter that isolates the contents of the drift tube from the atmospheric air. The drift tube has a minor electrical charge gradient, which draws the sample towards a receiving electrode at the end of the drift tube. Upon ion impact, an electrical charge is generated and recorded with respect to a travel time. The travel time is measured from the introduction gate to the receiving electrode.

The ions impact the electrode at different intervals providing a series of peaks and valleys in electrical charge that is usually graphed on Cartesian Coordinates. The Y-axis corresponds to the intensity of the charge received by impact of the various species that have respective travel times in the drift tube. This travel time in the drift tube and the strength of the charge gives a relative concentration of species in the sample.

3.1.2 Flame Photometry

Flame photometry detectors burn ambient air with hydrogen gas. The flame decomposes any chemical agents present in the air producing hydrogen phosphorus oxygen (HPO) from nerve agents and elemental sulfur (S_2) from mustards. At the elevated flame temperature the phosphorous and sulfur emit light of specific wavelengths. A set of optical filters is used to selectively transmit only the light emitted from the presence of phosphorous and sulfur to a photo-multiplier tube which produces an analog signal related to the concentration of the chemical agent in the air. Flame photometry is sensitive and allows ambient air to be sampled directly. However, it is also prone to false alarms from interferants that contain phosphorous and sulfur. The number of false positives due to interference can be minimized using algorithms. Using the flame photometer detector in cooperation with a gas chromatograph (see Section 3.3) will further reduce the likelihood of false alarms.

3.1.3 Photoacoustic IR Spectroscopy (PIRS)

Photoacoustic detectors use the photo-acoustic effect to identify and detect chemical agent vapors. When infrared radiation is absorbed by a gas it causes the temperature to rise which in turn causes the gas to expand. If the intensity of the infrared radiation is modulated the sample will expand and contract. If the modulation frequency is an audible frequency a microphone can be used to detect the resulting sound. Photoacoustic gas detectors use various filters to selectively transmit specific wavelengths of light that are absorbed by the chemical agent being monitored and as few interferants as possible. When no chemical agent is present in the atmospheric sample, the specific wavelength infrared light is typically not absorbed and, therefore, no audible signal is detected. When chemical agent is present in the sample an audible signal (at the frequency of modulation) is produced by the absorption of the modulated infrared light. Selectivity can be increased by sequentially exposing the sample to several wavelengths of light. Chemical agents are distinguished from interferants by the relative signal produced when several different wavelengths are sequentially transmitted to the sample. Photoacoustic detectors are sensitive to external vibration and humidity. However, as long as the detector is calibrated in every operating environment immediately prior to sampling, selectivity will be very high.

3.1.4 Electrochemistry

Electrochemical detectors work by monitoring the change in electric potential of a solution or thin film that is caused by the presence of a chemical agent. An example of one type of reaction is the inhibition of cholinesterase by nerve agents. A solution containing a known amount of cholinesterase is exposed to an air sample that may contain nerve agent. If nerve agent is present a percentage of the cholinesterase will be inhibited from reaction in the next step. The next step involves adding a solution containing a compound that will react with uninhibited cholinesterase to produce an electrochemically active product. The resulting cell potential is related to the concentration of uninhibited cholinesterase, which is related to the concentration of nerve agent present in the sampled air. Another type of electrochemical detector monitors the resistance of a thin film that increases as the film absorbs chemical agent from the air. Electrochemical detectors are selective, however they are not as sensitive as technologies such as IMS and flame photometry. Several of the fielded electrochemical detectors encounter problems when exposed to environmental extremes. Hot and cold temperatures change the rates of reactions and shift the equilibrium point of the various reactions thus affecting sensitivity and selectivity.

3.1.5 Colorimetric or Color Change Chemistry

Detector kits or tickets are wet chemistry techniques formulated to indicate the presence or absence of a chemical agent by a color change resulting from a chemical reaction involving the suspect agent. These kits are usually used to verify the presence of a chemical agent after an alarm is received from another monitor. The kits are also used to test drinking water for contamination. A similar detection method using this technology is detection paper, which contains a dye that is colorless when crystalline and colored when dissolved in a chemical agent. Detector papers are generally used for testing suspect droplets or liquids on a surface. For gaseous or vaporous chemical agents, colorimetric tubes are also available. These consist of a glass tube that has the reacting compound sealed inside. Upon use, the tips of the tubes are broken off and a pump is used to draw the sample across the reacting compound (through the tube). If a chemical agent is present, a reaction resulting in a color change takes place in the tube.

3.1.6 Surface Acoustic Wave (SAW)

Surface acoustic wave detectors consist of piezoelectric crystals coated with a film designed to absorb chemical agents from the air. SAW detectors use 2 to 6 piezoelectric crystals that are coated with different polymeric films. Each polymeric film preferentially absorbs a particular class of volatile compound. For example, one polymeric film will be designed to preferentially absorb water while other polymer films are designed to preferentially absorb different types of chemicals such as trichloroethylene, toluene, ethyl-benzene, or formaldehyde. The piezoelectric crystals detect the mass of the chemical vapors absorbed into the different, chemically selective polymeric coatings. The change in mass of the polymeric coatings causes the resonant frequency of the piezoelectric crystal to change. By monitoring the resonant frequency of the different piezoelectric crystals a response pattern of the system for a particular vapor is generated. This response pattern is then stored in a microprocessor. When the system is operating it constantly compares each new response pattern to the stored response pattern for the target vapor. When the response pattern for the target vapor matches the stored pattern, the system alarm is activated. The selectivity and sensitivity of these detectors depends on the ability of the film to absorb only the suspect chemical agents from the sample air. Many SAW devices use preconcentration tubes to reduce environmental interferences and increase the detection sensitivity.

3.1.7 Photo Ionization Detection (PID)

Photo ionization detectors work by exposing a gas stream to an ultraviolet light of an energy specific for the ionization of an agent molecule of interest. If agents are present in the gas stream they are ionized. An ion detector then registers a voltage proportional to the number of ions produced in the gas sample and thus the concentration of the agent. Specificity of these detectors is a function of how narrow the spectral range of the exciting radiation is and on how unique that energy is to ionizing only the molecule of interest.

3.2 Standoff Detectors and Alarms

Standoff and remote detectors are used to give advanced warning of a chemical agent cloud. Remote detectors can be configured with point detectors that are placed in remote locations and electronically networked to a central alarm system. This application requires the placement of the point detectors at a location believed to be at risk prior to any chemical agent contamination. Standoff detectors typically use optical spectroscopy and can detect chemical agents at distances as great as 5 kilometers. Agent free spectra must be used as a baseline to compare with freshly measured spectra that may contain chemical agent. Standoff detectors are generally more difficult to operate and usually require the operator to have some knowledge of spectroscopy in order to interpret results. Available standoff detectors use infrared spectroscopy with either passive or active sensing.

3.2.1 Passive (Forward Looking Infrared (FLIR), Fourier Transform Infrared (FTIR))

Passive FLIR spectroscopy uses an interferometer to collect the normal ambient background infrared radiation, emitted by the environment, and converts it mathematically into a spectrum of infrared frequency and intensity. This spectrum, if measured in the absence of a chemical agent cloud, represents a measure of the background radiation. When a chemical agent cloud is present in the optical path of the interferometer, it changes the background spectrum by selectively absorbing those infrared frequencies that are resonate with the molecular vibration frequencies of chemical agent molecules. The set of infrared frequencies that are absorbed by a molecule is unique and therefore the infrared spectrum of the cloud gives a positive identification of the chemical compounds in the cloud.

3.2.2 Active (Differential Absorption LIDAR)

Light detection and ranging (LIDAR) is the laser analog to radar. In LIDAR, a pulsed laser beam is sent out to a target object. Some of the light that is incident on the target is reflected back to the sender, and the rest is either scattered, reflected, transmitted or absorbed by the medium. The time it takes for the light to travel from the sender to the target and back to the sender is used to calculate the distance to the target. For studying clouds in the atmosphere, differential absorption LIDAR can be used to measure both the range of the cloud and the concentration profile of the cloud. In differential absorption LIDAR two laser beams of slightly different frequency are used to analyze the cloud. One of the frequencies is tuned to a molecular absorption of one of the molecules in the cloud (this requires prior knowledge of cloud composition). The intensity of the reflected beam is a function of how much laser light is absorbed by the cloud. This is related to concentration of the absorbing molecule in the cloud. The cloud does not absorb the second frequency. Since its frequency is similar to that of the first laser it will have a similar reflection and scatter profile. Thus the difference in the intensity of the two reflected beams will be due to absorption of the first laser beam by the cloud. The intensity of the return signal from the second laser beam is used as a baseline for calculating concentrations in the cloud. The time it takes for the two lasers to reflect back to the sender is used to calculate the range of the cloud. LIDAR is useful for tracking a chemical agent cloud once it has been identified, but typically can not be used to identify a chemical agent cloud.

3.3 Analytical Instruments

The analytical instruments described in this section can be used to analyze samples as small as a few micro liters or milligrams. They are designed to accurately measure the unique chemical properties of different molecules and to differentiate between different molecules based on their unique chemical properties. These instruments are quite sophisticated in order to detect and differentiate subtle differences between trace amounts of different molecules. Accuracy and reliability requires that only very pure reagents are used and that very rigid protocol and operating procedures are followed. This typically precludes their use outside of a laboratory environment staffed by technically trained people. Additionally, the instruments do not display the measured data in a straightforward manner. Interpretation of the measured data typically requires a technical background and extensive formal training.

3.3.1 Mass Spectrometry

Mass spectrometry is a technique that can positively identify a chemical agent at very low concentrations. In this technique a volatilized sample is ionized, typically by an electron beam which also causes the molecule to fragment into smaller ionized pieces. The ionized molecules and fragments are then passed into a mass analyzer that uses electric fields to separate the ions according to the ratio of their mass divided by their electric charge. The analyzer allows only ions of the same mass over charge ratio to impinge upon the detector. By scanning the electric potentials in the mass analyzer all the different mass/charge ions can be detected. The result is a mass spectrum, which shows the relative amount and the mass of each fragment and the un-fragmented parent molecule. Since each molecule forms a unique set of fragments, mass spectroscopy provides positive identification. To simplify interpretation of the mass spectrum it is best to introduce only one compound at a time. This is often achieved by using a gas chromatograph to separate the components in the sample. The end of the gas chromatography column is connected directly to the inlet of the mass spectrometer.

3.3.2 Gas Chromatography

The gas chromatograph uses an inert gas to transport a sample of air through a long chromatographic column. Each molecule sticks to the column with a different amount of force and does not travel down the column at the same speed as the carrier gas. This causes the chemical agents and interferants to come out the end of the column at different times (called the retention time). Since the retention time is known for the chemical agents the signal from an associated detector (i.e., PFD) is only observed for a short period starting before and ending just after the retention time of the chemical agent. This eliminates false alarms from similar compounds that have different retention times. False alarms from interferants can also be reduced by using a pre-concentrator. The pre-concentrator passes air through an absorbent filter that traps agent molecules. The filter is then isolated from the air and heated to release any chemical agent that may have been trapped. The released chemical agent is then pumped into the detector.

3.4 Equipment Capabilities and Limitations

Volume 2 of this report includes detailed information on the capabilities and limitations of known chemical detection equipment potentially capable of detecting chemical agents. The equipment reviewed and assessed for this effort are a representative sample of available items for each of the detection technologies described in section 3.0. The information provided in Volume 2 contains descriptions of the detector technology used and specifications that will be useful for making educated decisions on detector suitability. The characteristics of the equipment are categorized as operational, logistical, physical, and special. The equipment characteristics provided in Volume 2 are described in more detail in section 5.0.

4.0 Chemical Event Overview

The applicability of CWA detection equipment to off-post user groups will also be dependent upon the characteristics of the chemical accident or incident. Four aspects of the chemical event that are of significance include the chemical agent type, the event timeline, potential interferants, and potential off-post users. These aspects of the event are described in the following subsections.

4.1 Chemical Agents[2,3]

The target chemical agents for this assessment were limited to the three most common agents in the U.S. stockpile (GB, VX, and HD[4]). GB and VX are nerve agents and HD is a blister agent. The total quantity of each chemical agent at the U.S. stockpile locations as of 1996 is shown in Table 1.[5]

Table 1. Chemical Agent Quantities in the U.S. Stockpile

Chemical Agent	Quantity (tons)	Percentage of Stockpile
HD	17,069.12	57.9
GB	8,288.59	28.1
VX	4,092.68	13.9
Other	15.01	0.1
Total	29,465.40	100

[2] Headquarters, Departments of the Army, Navy, and Air Force. Potential Military Chemical/Biological Agents and Compounds. Army Field Manual 3-9, Navy Publication P-467, Air Force Manual 355-7. Dept. Army, Navy, and Air Force. 1990

[3] Headquarters, Department of the Army. The Army Chemical Agent Safety Program. Army Regulation 385-61. February 1997.

[4] Note that the mustard agents (HD, H, HT) are denoted as HD in this report

[5] Federal Emergency Management Agency and Department of the Army. "Planning Guidance for the Chemical Stockpile Emergency Preparedness Program". May, 1996.

Characteristics discussed in this section are those that are relevant to the detection and identification of the chemical agents in an emergency scenario. Human interface and detailed medical effects are not discussed. Detailed chemical agent information can be found in the Final Programmatic Environmental Impact Statement (FPEIS).[6]

Understanding the chemical and physical properties of a chemical agent is critical when confronting the agent in the field. The behavior of chemical agents is dependent on weather variables such as wind, temperature, and humidity. Depending upon the properties of the chemical agent, the type of release, and the weather conditions, agents could appear as vapors, aerosols, or liquids. Note that the physical state of significance to off-post users is the vapor state.

The detection limits that are of interest for this study are the eight-hour Time Weighted Average (TWA-8) and the Immediately Dangerous to Life and Health (IDLH). The TWA-8 is defined as the maximum dosage (converted to a concentration) that may be received averaged over an 8-hour workday exposure. The IDLH is defined as the concentration at which self contained breathing apparatus (SCBA) or respirators must be worn or immediate life threatening affects will occur. These limits are determined by the U.S. Department of Health and Human Services and are listed in the U.S. Federal Register.

4.1.1 Sarin (GB)

The following subsection describes the relevant properties of GB.

- The boiling point is 158 °C (316.4 °F) in pure form and 151 °C (303.8 °F) in plant grade.
- The freezing point is -56 °C (-68.8 °F).
- The ratio of the vapor density of sarin compared to air is 4.86.
- The vapor pressure at ambient temperature (20 °C) is 2.10 mm Hg and is not flammable.
- The latent heat of vaporization is 80 calories per gram at 25 °C.

Other important detection parameters to consider include critical limits of exposure and concentrations of the chemical agent. Tables 2 and 3 present toxicity properties. Toxicity properties relate to the degree of danger posed by the chemical agent to human life. The LCt_{50} is the concentration of an agent (mg/m^3) over a specified time period (minutes) that is lethal to fifty percent of the exposed population. The ICt_{50} is the concentration of an agent (mg/m^3) over a specified time period (minutes) that is incapacitating to fifty percent of the exposed population.

[6] Final Programmatic Environmental Impact Statement. January 1988, U.S. Army PMCD.

Table 2. Respiratory Toxicity Data for GB

Threshold Value	Resting (mg-min/m^3)	Mildly Active (mg-min/m^3)
LCt_{50}	100	70
ICt_{50}	75	35

Table 3. Percutaneuous Toxicity Data for GB

Threshold Value	Naked (mg-min/m^3)	Normally Clothed (mg-min/m^3)
LC_{50}	12,000	15,000
ICt_{50}	-	8,000

4.1.2 VX

The following subsection describes the relevant properties of VX.

- The boiling point is 298 °C (568.4 °F).
- The freezing point is -51 °C (-59.8 °F).
- The ratio of the vapor density of VX compared to air is 9.2.
- The vapor pressure at ambient temperature (20 °C) is 0.0007 mm Hg with a flashpoint of 159 °C (318.2 °F).
- The latent heat of vaporization for VX is 78.2 calories per gram at 25 °C.
- VX differs from GB in that it is about 2,000 times less volatile (10.5 mg/m^3 at 25 °C).

Other important detection parameters to consider include critical limits of exposure and concentrations of the chemical agent. Tables 4 and 5 present toxicity properties.

Table 4. Respiratory Toxicity Data for VX

Threshold Value	Resting (mg-min/m^3)	Mildly Active (mg-min/m^3)
LCt_{50}	100	30
ICt_{50}	50	24

Table 5. Percutaneuous Toxicity Data for VX

Threshold Value	Naked (mg-min/m^3)	Normally Clothed (mg-min/m^3)
LC_{50}	6 – 360	6 - 3,600

4.1.3 Mustard (HD)

The following subsection describes the relevant properties of HD.

- The boiling point is 12.8 °C (55.0 °F) and the freezing point is -6.9 °C (19.6 °F).
- The ratio of the vapor density of HD compared to air is 2.1.
- The vapor pressure is 0.11 mm Hg at 25°C and is not flammable.
- The latent heat of vaporization is 103 calories per gram at 25°C.
- Volatility is 6.1 kg/m^3 at 25 °C and 2.6 kg/m^3 at 12.8 °C.

Other important detection parameters to consider include critical limits of exposures and concentrations of the agent. Table 6 presents toxicity properties.

Table 6. Respiratory Toxicity Data for HD

Threshold Value	Respiratory (mg-min/m^3)
LCt_{50}	1,500
ICt_{50}	150

Table 7. Percutaneuous Toxicity Data for HD

Threshold Value	Percutaneuous (mg-min/m^3)
LCt_{50}	10,000
ICt_{50}	<2,000

4.2 Event Timeline[7]

The timing of a chemical event could impact the selection of chemical detection equipment. User requirements will likely differ during the crisis and consequence management stages. Time will not be available for extensive data collection and prolonged decisions. The detector requirements most likely to be impacted by the event timeline include the response time and the start-up time. For example, if the concentration of chemical agent on the leading edge of the plume is high enough to be immediately life threatening, some detectors may not provide some user groups sufficient time to take protective measures.

The timelines associated with stockpile chemical events have been approximated using several models, including atmospheric dispersion models and evacuation models. The dispersion models indicate that there is extreme variability associated with the timing of these events. Variables such as wind speed, temperature, air stability, precipitation, and the extent of the release will directly effect the size of the plume, the speed of the plume, the direction of the

[7] Sorenson, J.H. "Evaluation of Warning and Protective Action Implementation Times for Chemical Weapons Accidents." ORNL/TM-10437. April 1988.

plume, and the concentration gradient in the plume. The time required to institute protective measures, such as evacuation or expedient sheltering, is also variable. These times are dependent upon factors such as the time of day the release occurs, the adequacy of the local roadway system, and the skill level and training of off-post civilians. The extreme variability associated with these events makes it very difficult to precisely define detection equipment requirements.

4.3 Potential Interferants[8]

Potential interferants are an important factor that must be considered in the selection of a chemical agent detector. A false positive alarm will cause civilians to take all necessary emergency actions, and some of those actions may result in injuries or, in rare cases, fatalities. False alarms should be avoided as a matter of preserving public safety and maintaining public trust. Interferants that have been identified in the past through testing and/or field operation are presented in Table 7. These interferants are considered to be non-battlefield interferants. Note that this is a summary list of potential interferants. Interferants applicable to specific detectors are listed on the detector information sheets in Volume 2 of the report.

[8] Aiken, Barnes, Barrett, Boiarski, Bowen, Carleton, Golly, Haselwood, and Kenny. *Candidate Selection Report, Market Survey of Low-Level Chemical Safety Monitors for Application at U.S. Chemical Weapons (CW) Storage Sites*, Battelle, 1996

Table 8. Non-Battlefield Interferants

Non-Battlefield Interferants[9]	
Aqueous Film Forming Foam (AFFF-Fire Fighting Foam)	Household Ammonia
Brake Fluid	Hydraulic Fluid
Brush (Burning)	Insect Repellants including aerosols, Insect/Anthropoid repellant, 75% Cream Item Insecticide, Pyrethrum, Malathion 50%
Cardboard (Burning)	Isopropanol
Cigarette Smoke	Jet Propellant - i.e., JP4, JP8 (vapor, combustion by-products)
Cloth - Cotton-poly (Burning)	Kerosene (vapor, combustion by-products)
Diesel Fuel (vapor, combustion by-products)	Menthol Based Supplies (i.e., Ben-Gay)
Doused Fire	Motor Oil
Fresh Cut Grass	Plastic (Burning)
General Purpose Cleaners	Tires (Burning)
Gasoline (vapor, combustion by-products)	Wet and Dry Vegetation Burning
Halon	Wood (Burning)

4.4 Potential Off-Post Users

Characteristics of the potential off-post user group could directly impact the selection of chemical detection equipment. The detector requirements most likely to be impacted by the user group include the skill level and training requirements. The off-post population is extremely large and diverse and various potential user groups could have differing requirements. User groups will maintain specific roles during a chemical event, and these groups will likely possess differing skill levels. A typical civilian will either evacuate or shelter, whereas an emergency responder may be responsible for decontamination of casualties or equipment. Although an extensive survey was not performed, based upon previous investigations, a typical civilian will have no technical background and a hazardous materials responder will have minimal technical background.[10]

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[9] Aiken, Barnes, Barrett, Boiarski, Bowen, Carleton, Golly, Haselwood, and Kenny. *Candidate Selection Report, Market Survey of Low-Level Chemical Safety Monitors for Application at U.S. Chemical Weapons (CW) Storage Sites*, Battelle, 1996

[10] Janus, Hawley, Golly, Barrett, Baig, and Herman. *Assessment of Chemical Detection Equipment for HAZMAT Responders*, Battelle, 1997.

5.0 Assessment Parameters

The objective of a detection equipment assessment is to determine if the capabilities of available equipment match the requirements of the potential users. CWA detection equipment capabilities and limitations are described in Volume 2. Section 4.0 describes background information on potential chemical stockpile events that provides the basis for developing user requirements. Note that the assessment process described in this report focuses on the technical aspects of the detection equipment and does not account for on-site procedures, equipment, or capabilities.

The requirements of an off-post user group may be classified as operational, logistical, physical, and special. Operational requirements include equipment sensitivity, selectivity, response time, and start-up time. Logistical requirements include ease of operation, maintainability, supportability, and cost. Physical requirements include size, weight, and transportability. Special requirements include regulatory considerations and interface requirements. Note that the categorization of user requirements corresponds to the categorization of detection equipment characteristics described in Volume 2. User requirements and equipment characteristics were defined in a similar fashion to simplify the assessment process.

The following subsections define each of the characteristics listed in Volume 2, and also describe the relevance of the characteristic to a potential user. These subsections serve as a guide to Volume 2 and also as a basis for developing mission-specific requirements.

5.1 Description

The subsections for the "Description" section are as follows:

Manufacturer. The manufacturer subsection contains the name, address, phone number, and point of contact for the detector manufacturer. Note that some equipment may have multiple manufacturers. This information will be of value to a user who is considering acquisition of detection equipment.

Technology. The technology subsection contains a brief description of the technology used by the detector. More detailed descriptions of the detector technologies are provided in Section 3.0. Examples of equipment technology include surface acoustic wave and ion mobility spectroscopy. Detectors that use the same technology will commonly possess similar capabilities and limitations. For example, certain technologies inherently require extensive technical backgrounds for operation (i.e., mass spectroscopy). Given the requirements of a specific user mission, all detectors based upon a certain technology may be excluded from consideration.

Type. The type subsection indicates if the detector is a commercial and/or military detector. Military detectors have generally been subjected to more extensive testing, including live chemical agent and severe environmental testing. Most commercial equipment has not been subjected to live chemical agent testing. The physical state of the sample that can be detected is also described in this section (i.e., vapor, aerosol, or liquid). A single detector will usually not detect chemical agents in all three physical states. As previously mentioned, off-post applications will require detection of the vapor state. The use of multiple detectors will typically require additional maintenance, training, skill level, cost, and space. Equipment that detects multiple chemical agents is usually more complex.

National Stock Number. If applicable, this subsection lists the national stock numbers that apply to the unit. National stock numbers apply only to equipment that is used by the military. This information will also be of value to a user who is considering acquisition of detection equipment.

5.2 Operational Parameters

The subsections for the "Operational Parameters" section are as follows:

Chemical Agent Detection. The chemical agent detection subsection lists which of the three target agents (GB, VX, and HD) can be detected. A user group should strive to acquire a single detector that detects all relevant chemical agents. The use of multiple detectors will typically require additional maintenance, training, skill level, cost, and space. Equipment that detects multiple chemical agents is usually more complex.

Sensitivity. The sensitivity subsection lists the lowest concentration of chemical agent that can be detected. Sensitivity limits are agent-dependent and also vary with environmental conditions. Sensitivities listed are usually determined under optimal conditions. Sensitivity is significant to the user because it is closely related to warning time. The warning time will increase as the detection limit of the detector decreases. The exact relationship between the two is uncertain due to the variability associated with chemical events. Equipment should detect chemical agents well below dangerous concentrations (below IDLH or TWA-8) in order to provide users enough time to take protective measures. The cost and complexity of detection equipment typically increases as its sensitivity decreases.

The sensitivity subsection also lists if the equipment possesses an audible or visual alarm. The type of alarm required will be dependent upon the mission. Users who may not have visual access to the equipment, such as traffic control personnel, will require audible alarms. Other users, such as decon personnel, may not desire an audible alarm due to the panic that casualties may experience.

Selectivity/Interferants/False Alarms. Selectivity is a measure of the instrument's ability to distinguish between varying compounds in a sample. An interferant is a compound that causes a detector to false alarm. The two types of false alarms are false positive and false negative. A false positive occurs when no chemical agent is present, but the detector still alarms. A false negative occurs when chemical agent is present, but the detector fails to alarm. A detector with poor selectivity will typically be prone to false alarms. Section 4.3 discusses interferants known to cause false alarms.

The tendency to false alarm is a highly undesirable characteristic. Personnel and civilians will respond to a false positive alarm as though it were a genuine detection of chemical agent. A false positive alarm will cause personnel and civilians to take all necessary emergency actions. The consequences of a false negative alarm are apparent. False alarms should be avoided as a matter of preserving public safety and maintaining public trust. To achieve negligible or zero false alarm rates may require detectors to employ sophisticated algorithms or electronics. Equipment that does not false alarm to non-battlefield interferants (as listed in section 4.3) is categorized as highly selective. Equipment that will false alarm to these interferants is categorized as not highly selective. Users should acquire equipment that is highly selective, or have control measures in place to deal with false alarms.

Response Time. Response time is the time it takes for a detector to collect a sample, analyze the sample, determine if a chemical agent is present, and provide feedback. Equipment may respond in real time, or response could take hours. Real time response is typically defined as within one minute. Response time is usually slow when detection limits are extremely low.

Response time is significant to the user because it is closely related to warning time. Warning time increases as response time decreases. Significant delays in response may not be acceptable in many cases. For example, delayed response could slow the decontamination of personnel so drastically that serious injury could incur as a result of additional exposure.

Start-Up Time. Start-Up Time is defined as the time required to setup and begin sampling with an instrument. Time is measured from the instant the instrument is removed from storage until the time the unit is able to provide analysis. Start-up time could range from several seconds to several hours depending upon the complexity of the equipment. Start-up time is significant to the user because it is closely related to warning time. Warning time increases as start-up time decreases. Start-up time is more critical to personnel involved with crisis management than it is to personnel involved with consequence management. Equipment with significant start-up times commonly require operators with technical backgrounds.

5.3 Logistical Parameters

The subsections for the "Logistical Parameters" section are as follows:

Ease of Operation. The ease of operation subsection defines the skill level and the training that is required for proper operation of the instrument. The skill level and training requirements are subjective characteristics of the equipment. The three categories for skill, starting with the most advanced, are Technical Specialist, Technical Background, and No Technical Background.

The Technical Specialist will generally have an advanced science degree (i.e., Chemistry, Engineering) and be able to interpret data acquired with analytical equipment. A Technical Specialist would also be capable of trouble shooting equipment problems and performing both regular and preventative maintenance. The Technical Specialist category may also be satisfactorily met if the user has a significant amount of laboratory or analytical experience. Technical Background is defined as someone who generally has an undergraduate degree in a technical field, a degree from a technical school, or 2 years experience operating electronic, laboratory or test equipment. This person should be able to trouble shoot minor problems with the instrument, and perform regular and preventive maintenance. A person with a technical background should be able to make inferences about a situation based on instrument readings. No Technical Background is a person who generally has a high school education and has minimal or no experience operating electronic, laboratory, or test equipment. The person should be capable of following instructions written with technical language.

The two training levels are Formal Training required and No Formal Training required. Formal Training requires an instructor trained to teach operation, maintenance and interpretation of the detector output. The training may consist of classroom lectures with laboratory hands-on operation of the detector. No Formal Training means the user can operate the detector after reading the instructions or receiving an informal demonstration by someone familiar with the detector operation.

User groups must consider the skill level of their members and the time available for training when acquiring detection equipment. Most user groups will not be able to provide or maintain a technical support staff to operate the detection equipment. Given this, the technical skill level required to operate the equipment and the quantity of training required should be minimal. Simplicity generally decreases the time required to operate the detector, thereby freeing personnel for other essential operations. Some missions may provide a readily available training environment making the necessity for minimal training less of a concern (i.e., emergency service personnel are typically required to attend monthly training).

Maintainability/Supportability. The maintainability and supportability subsection defines the additional equipment, supplies and labor necessary to calibrate and ensure reliable operation of the instrument. A list of consumable materials used during operation and a list of waste generated from operation is provided in this section as well as the level of repairs. This subsection also addresses the run time of the equipment. Run time is typically dependent upon the power source and is usually not a limiting factor of the equipment. The run time of some equipment is restricted by consumables.

For most missions, maintainability and supportability are related to the ease of operation and the space claim. Equipment that requires extensive maintenance and support is typically complex and difficult to operate. Additional equipment and supplies also demand space in excess of that required by the detector and transport container. This space may not be available for some missions. Users should strive to acquire equipment that requires no additional components or supplies to ensure continued performance.

Cost. The cost parameter lists the initial cost and the approximated annual cost. The annual cost consists of the training cost, supportability cost, and maintenance cost. User groups should consider the total cost (initial plus annual) and the cost/benefit relationship when making an equipment acquisition decision. Cost is closely related to every other equipment characteristic. In general, cost will increase as sensitivity increases, as selectivity increases, as ease of operation increases, and as maintainability and supportability decrease. User groups should also consider the quantity of detectors that must be acquired when determining an appropriate cost limit.

5.4 Physical Parameters

The subsections for the "Physical Parameters" section are as follows:

Size. The size subsection lists the dimensions of the equipment. Size is typically related to transportability. The size requirements specified are influenced by the specific application. For missions in which the detector will be stored in the trunk of a police car, for example, space is limited due to other equipment that is required for daily operation of the officer. Users must also allow for transport containers.

Weight. The weight subsection lists the weight of the equipment. Weight is also related to transportability. If the equipment is required to be man portable, the weight should be less than 23 kg (50 lbs.) to ensure operator safety. If the mission requires vehicle mounted detectors, for example, the weight capacity should be considered with respect to the transporting vehicle. Some equipment may require vehicle modification to withstand the additional weight.

Transportability. The transportability subsection defines the number of people and the type of equipment required to transport the detection equipment. The transportability requirement is categorized as man-portable, vehicle portable, or not portable. As previously mentioned, transportability is directly related to size and weight. The mission of the user group will determine the transportability requirements. For example, a decontamination crew may need to travel to various locations and then scan casualties at a considerable distance from a vehicle. This mission would require equipment that is man-portable. This subsection also describes any special storage requirements.

5.5 Special Requirements

The subsections for the "Special Requirements" section are as follows:

Regulations. The regulation subsection gives a description of any special licenses, training, or skill level requirements that are mandated to own, operate, or transport the instrument. User groups should strive to acquire equipment that is not affected by burdensome regulation. Detectors that utilize a radioactive source, for example, will require a NRC license and specialized training and maintenance.

Interface Requirements. The interface subsection lists the power source requirements and any auxiliary equipment necessary for effective operation of the detector. Detection equipment will sometimes require atypical power sources or additional equipment to operate. User groups should consider their available power sources and the cost of auxiliary equipment before making an acquisition decision. If the detector will be carried in a police car, for example, it would be beneficial to ensure that the detector can operate on 12 VDC vehicle power or batteries.

Safety. The special requirements section also addresses the operational safety of the equipment. The information sheets highlight equipment that is not considered to be intrinsically safe to operate. A detector that could be explosive in some environments, for example, is not considered to be intrinsically safe.

6.0 Detection Equipment Assessment

The previous section provided a set of generic criteria that should be refined by the user to address a specific mission. In order to illustrate the process, two potential missions were examined to assess the match between user needs and available equipment. The objective was to develop missions that would be representative of probable off-post applications. These missions were analyzed to provide emergency managers with a realistic example of how the survey and assessment tool may be utilized.

In the first mission, the user group is off-post decontamination personnel. In the second mission, the user group is traffic control point (TCP) personnel. In order to conduct a meaningful assessment, these missions required the inclusion of assumptions about the user group and the chemical event. Given the variability of local concepts of operation, rules, and laws, the missions described should be tailored to address each specific application.

6.1 Mission 1: Decontamination Site

The first mission describes the potential requirements to certify that personnel passing through a decon site are not contaminated. This user group should be operating outside the protective wedge. The primary assumption associated with this mission is that User Group 1 will be responsible for decontamination of casualties only. User Group 1 will certify casualties free of contamination before transport to a definitive care facility. It is also assumed that the decon user group will be composed of emergency responders with expertise in hazardous materials (HAZMAT). Additional assumptions are included in the following requirements.

6.1.1 Operational Requirements

The operational requirements for User Group 1 are described below.

Chemical Agent Detection. User Group 1 should acquire detection equipment that detects GB, HD, and VX in vapor form. A single piece of equipment is preferred over multiple detectors due to the probable decrease in training, maintenance, cost, skill level, and space claim requirements.

Sensitivity. The equipment should indicate when the concentration reaches 80 percent of the TWA value for each chemical agent. Equipment that does not detect well below the IDLH level will not be beneficial to off-post decon personnel. An audio or visual alarm is not necessary for this user group. Alarms could be detrimental to casualties. Highly sensitive equipment is necessary to ensure that contaminated casualties are not transported to definitive care facilities.

Selectivity. The detector should not false alarm in the presence of potential interferants, as defined in section 4.3. Selectivity is critical for this user group. False alarms are to be avoided as a matter of preserving public safety. False alarms will create unnecessary logistical problems for decon personnel, unnecessary panic for casualties, and unnecessary health risks at definitive care facilities. Equipment should be highly selective.

Response Time. In order for User Group 1 personnel to execute their duties, detector response must occur in real time. For the purpose of this assessment, it is assumed that the response time should be less than 60 seconds for the sensitivity described in the operational requirements. Short response time is a necessity for User Group 1 personnel in order to facilitate rapid decon and verification of successful decon.

Start-Up Time. Decon personnel should acquire detection equipment that has minimal (< 2 minutes) start-up time. It is essential that responders be capable of rapid detection if a chemical stockpile event has occurred. Decon personnel may have additional time for start-up due to the time associated with assembling a decon station (approximately 15 minutes). This only applies if equipment start-up involves negligible operator intervention.

6.1.2 Logistical Requirements

The logistical requirements of the responder user group are described below.

Ease of Operation. Although an extensive survey was not conducted for this effort, it is assumed that the majority of User Group 1 personnel will not possess an extensive technical background. Given the typical profile of a HAZMAT responder, equipment should be designed for operation by users with minimal technical background and minimal formal training. In contrast to the difficulties of providing formal training to a large group of diverse civilians, formal training for User Group 1 personnel can be integrated into other required training courses.

Maintainability/Supportability. The detection equipment should not require chemical agents for calibration. Calibration should also not be required prior to each usage. In addition, the use of consumables should be minimized. The equipment should not produce any Resource Conservation and Recovery Act (RCRA) defined hazardous waste. The detector should be maintainable and supportable by User Group 1. This eliminates the need for an extensive technical staff to maintain the detectors. The run-time should only be dependent upon power sources, and not restricted by consumables. The level of maintenance/support required per annum should not exceed 12 hours.

Cost. The quantity of decon sites required following a chemical event should be relatively small. Each decon site will likely possess multiple detectors to ensure that detection does not inhibit the pace of the personnel decon station. It is assumed that the initial cost should not exceed $3000 per unit and the annual cost should not exceed $500 per unit.

Size. Space claim on a HAZMAT vehicle is minimal due to the additional equipment that is mandatory for daily operation. Although the assumption is that response vehicles will be equipped with detection equipment, the original role of the vehicle must be maintained. Existing equipment can not be removed to accommodate detection equipment. Given this, the equipment size should less than 0.03 cubic meters (i.e., small suitcase).

Weight. The detection equipment should not require the vehicle to be modified to support the additional weight. The detector should be man-portable (< 23 kg).

6.1.3 Special Requirements

Special requirements could include a variety of topics. For this use concept, the equipment should not require any special licensure (i.e., Nuclear Regulatory Commission permit). The detection equipment should also operate on standard power sources (110 VAC, 12VDC vehicle, or battery power). This equipment should be intrinsically safe for transport, operation, and storage.

6.1.4 Assessment

The assessment for Mission1 revealed that none of the detectors surveyed meet all of the requirements for decontamination personnel (based upon assumptions described above). Detectors that match a high percentage of the requirements, with the exception of sensitivity and selectivity, include the colorimetric techniques A26 (Paper, Chemical Agent Liquid Detectors, 3-Way**),** and A27 (C2 Chemical Agent Detector Kit). Detectors A47 (Pragmatic M923 and M626) and A31 (Nerve Agent Vapor Detector) are a fair match, but they also lack the required sensitivity. The detectors with the required sensitivity are expensive and require a technical background. Note that the detector that matches the highest percentage of requirements is not necessarily the optimal choice because some requirements may be essential to the mission. For example, Detector A24 (M8 Paper) matches a high percentage of the requirements, but is of little use to this mission because it cannot detect chemical agents in the required physical state.

Tables 9, 10, and 11 indicate with a check mark the detectors described in Volume 2 that meet that selected requirement. An "X" indicates that the selected requirement is not met. Shaded areas indicate that vendor verification was not obtained. Blank cells indicate that information is not currently available. A detector index can be found in Appendix A.

Table 9. Mission 1: Point Detectors Assessment

DETECTOR	Agents Detected	Alarms	Sensitivity	Selectivity	Response time	Start up time	Ease of ops.	Maintainability	Cost initial	Cost yearly	Size	Weight	Transportable	Regulations	Interface
A1	✓	✓	X	✓	X	✓	X	✓	X		✓	✓	✓	X	
A2	X	✓	X	X	X	X	✓	✓	X		✓	✓	✓	X	✓
A3	✓		X	X	✓		✓	✓			✓	✓	✓	X	✓
A4	✓	✓	X	✓	✓	✓	X	✓			✓	✓	✓	X	✓
A5	✓	✓	X	X	✓	X	X	✓	X		✓	✓	✓	X	✓
A6	✓	✓	X	X	✓	X	X	✓	X		✓	✓	✓	X	✓
A7	✓	✓	X	X	X	✓	X	✓	X		✓	✓	✓	X	✓
A8	✓	✓	X	X	X	X	X	✓	X		✓	✓	✓	X	✓
A9	✓	✓	✓	X	✓	X	✓	✓	X	✓	✓	✓	✓	X	✓
A10	✓	✓	X	X	X	X	X	✓			✓		✓	X	✓
A11	✓	✓	X	X	X	X	X	✓			✓	✓	✓	X	✓
A12	✓	✓		X	✓		X	✓	X		X	X	X	X	✓
A13	✓	✓	X	X	✓	✓	✓	X	X	X	✓	✓	✓	X	X
A14	✓	✓	X	X	✓	✓	✓	✓	X	✓	✓	✓	✓	X	✓
A15	X	✓	X	X	✓		X	✓			✓	✓	✓	X	✓
A16	✓	✓	X	X	✓		X	✓	X		✓	✓	✓	X	
A17	✓	✓	X	✓	X	X	X	✓	X			✓	✓	X	✓
A18	✓	✓	X	✓	✓	X	X	✓	X		✓	✓	✓	X	✓
A19	X	✓	X	X	✓		X	X	✓		✓	✓	✓	✓	✓
A20	X	✓	X	X	✓		✓	✓	✓		✓	✓	✓	✓	✓
A21	✓	✓	X	✓			X	✓			X	✓	✓	✓	✓
A22	X	✓	X	✓			X	X			✓	✓	✓	X	✓
A23	X	✓	X	X	✓		X	✓			✓	✓	✓	✓	✓
A24	X	✓	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A25	X	✓	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A26	X	✓	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A27	✓	✓	X	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A28	✓	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓	✓
A29	✓	✓	X	X	X	✓	✓	X	✓	✓	✓	✓	✓	X	✓
A30	X	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓	✓
A31	X	✓	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A32	✓	✓	X	X		X	✓	✓			✓	✓	✓	✓	✓
A33	✓	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓	✓
A34	✓	✓	X	X	✓	✓	X	✓	X		✓	✓	✓	✓	✓
A35	✓	✓	X	X	✓	✓	X	✓	X		✓	✓	✓	✓	✓

DETECTOR	Agents Detected	Alarms	Sensitivity	Selectivity	Response time	Start up time	Ease of ops.	Maintainability	Cost initial	Cost yearly	Size	Weight	Transportable	Regulations	Interface
A36	✓	✓	X	X	✓	X	X	✓				✓	✓	✓	✓
A37	✓	✓	X	X	✓	✓	X	✓	X	X	✓	✓	✓	✓	✓
A38	✓	✓	X	X	✓	✓	✓	✓	X	✓	✓	✓	✓	X	✓
A39	✓	✓	✓	✓	X		X	X	X		✓	✓	✓	X	✓
A40	✓	✓	X	✓	✓	X	X	X	X	X	X	✓	✓	X	✓
A41	✓	✓	✓	X	X		X	X			X	✓	✓	X	✓
A42	X	✓	X	X			X	✓				✓	✓	✓	✓
A43	X	✓	X		X		X	✓	X		X	✓	✓	✓	✓
A44	✓	✓	✓	✓	✓		X	X			✓	✓	✓		✓
A45	X	✓	✓	✓	✓		X	X	X		X	X	X	✓	✓
A46	✓	✓	✓	✓	X		X	X				✓	✓	✓	✓
A47	✓	✓	X		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
A48	X	✓	X	X	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	✓

Table 10. Mission 1: Standoff Detectors Assessment

DETECTOR	Agents detected	Alarms	Sensitivity	Selectivity	Response time	Start up time	Ease of ops.	Maintainability	Cost initial	Cost yearly	Size	Weight	Transportable	Regulations	Interface
B1	✓	✓	X	✓	✓	X	X	X	X		X	✓	X	✓	X
B2	X		X	✓	✓	X	X	X			X	✓	✓	✓	X
B3	✓	X	X	✓	✓	X	X	X	X		X	X	✓	✓	X
B4	✓	✓	X	✓	✓	X	X	X			X	X	✓	✓	✓
B5	X	✓	X	✓	✓	X	X	X	X		X	X	✓	X	✓

Table 11. Mission 1: Analytical Instruments Assessment

DETECTOR	Agents detected	Alarms	Sensitivity	Selectivity	Response time	Start up time	Ease of ops.	Maintainability	Cost initial	Cost yearly	Size	Weight	Transportable	Regulations	Interface
C1	✓	✓	✓	✓	X	X	X	X					X	✓	X
C2	✓	✓	✓	✓	X	X	X	X					X	✓	X
C3	✓	✓	X	✓	✓	X	X	✓	X	X	X	X	X	✓	✓
C4	✓	✓	✓	✓	✓	X	X	✓	X		X	X	✓	✓	✓
C5	✓	✓	✓	✓	X	X	X	X	X	X	X	X	X	✓	✓
C6	✓	✓	✓	✓		X	X	X	X	X	X	X	X	X	✓
C7	✓	✓	✓	X	X	X	X	X			X	X	✓	X	✓
C8	✓	✓	X	X	X	X	X	X			X	X	✓	X	✓
C9	✓	✓	✓	✓	X	X	X	X				X	✓	X	✓
C10	✓	✓	✓	✓	X	X	X	X					X	X	✓
C11	✓	✓	X	✓	X	X	X	X	X	X	X	X	X	X	✓
C12	✓	✓	✓	✓	X		X	X					X	✓	X
C13	✓	✓	✓	✓		X	X	X	X		X	X	X	X	✓
C14	✓	✓	✓	✓	X	X	X	X	X	X	X	X	X	X	✓
C15	✓	✓	✓	✓	X	X	X	X	X	X	X	X	X	X	✓
C16		✓	X	✓	X	X	X	X	X	X	X	X	X	✓	✓
C17	✓	✓									✓	✓	✓		✓
C18	✓	✓	X		X	X	X	✓				X	X	✓	✓
C19	X	✓	X	✓	✓	X	X	✓	X		✓	✓	✓	X	✓
C20	X	✓	✓	✓	X	X	X	X				X	X	✓	✓
C21	✓	✓	X	✓	X	X	X	X	X	X	X	X	X	X	✓

6.2 Mission 2: Traffic Control Points

The second mission describes the potential requirements of off-post emergency responders at traffic control points (TCPs). Traffic control points will be established at strategic locations outside the boundary of the projected plume. TCPs will exist in the Immediate Response Zone (IRZ), the Protective Action Zone (PAZ), and potentially the Precautionary Zone (PZ). Responders at TCPs will have a dual responsibility that includes traffic control and contamination avoidance. Traffic control entails directing and monitoring civilian traffic as residents evacuate the zones affected by the projected plume. Contamination avoidance involves monitoring the movement of the plume during the event to verify the simulated plume position and thereby ensure the safety of civilians and responders.

TCPs will likely be operated by responders from the police department. State and local government employees could potentially provide additional assistance. It is assumed that each responder assigned to a TCP will be equipped with CWA detection equipment that is stored in their respective vehicle. Additional assumptions are included in the following requirements.

6.2.1 Operational Requirements

The operational requirements of this user group are described below.

Chemical Agent Detection. TCP responders should acquire detection equipment that detects GB, HD, and VX in vapor form. A single piece of equipment is preferred over multiple detectors due to the probable decrease in training, maintenance, cost, skill level, and storage requirements.

Sensitivity. The equipment should include an audible alarm that will alert the responder group. This audible alarm should have the capability to warn the responder in the presence of automobile traffic. The equipment should detect and alarm when the concentration reaches 80 percent of the TWA value for each chemical agent. Equipment that does not detect well below the IDLH level will not be beneficial to this user group. Sensitivity to low concentrations is required in order to provide adequate time for responders to redirect traffic, relocate TCPs, and perform other necessary duties. Responders and civilians in automobiles will have virtually no protection from the chemical agent cloud.

Selectivity. The detector should not false alarm in the presence of potential interferants, as defined in section 4.3. Common non-battlefield interferants will be prevalent in this environment. Specific interferants of concern would include gasoline and diesel combustion by-products and common automobile liquids. The tendency to false alarm is therefore a highly undesirable characteristic. TCP personnel will respond to any alarm as though it was a genuine detection of chemical agent. A false alarm will cause responders to take all necessary emergency actions. False alarms are to be avoided as a matter of preserving public safety. Equipment should be highly selective.

Response Time. The variability associated with a chemical event makes the required response time very difficult to precisely define. The response time requirement will be dependent upon parameters such as the concentration gradient in the plume, wind speed, wind direction, and evacuation time. In order for TCP personnel to execute their roles, response must occur in real time. Following an initial alarm, responders will be required to make additional measurements to help determine the expansion of the plume beyond its simulated location. The process of locating the plume boundary may require multiple measurements over a short time frame. This will require a detector with a quick response time. For the purpose of this assessment, it is assumed that the response time should be less than one minute for the sensitivity described in the operational requirements.

Start-Up Time. TCP responders should acquire detection equipment that has minimal (< 1 minutes) or no start-up time. It is essential that responders responsible for traffic control be capable of immediate detection if a chemical stockpile event occurs.

6.2.2 Logistical Requirements

The logistical requirements of the responder user group are described below.

Ease of Operation. Although an extensive survey was not conducted for this effort, it is assumed that the majority of TCP personnel will not possess a technical background. Given the typical profile of a responder responsible for traffic control, equipment should be designed such that users with no technical background and minimal formal training can operate the equipment. An additional consideration is that TCP personnel will also be responsible for controlling traffic. This dictates that the equipment must be automated and not require human intervention (other than start-up).

Maintainability/Supportability. The detection equipment should not require chemical agents for calibration. Calibration should also not be required prior to each usage. In addition, the use of consumables should be minimized. The equipment should not produce any RCRA defined hazardous waste. The detector should be maintainable and supportable by TCP personnel thus eliminating the need for an extensive technical staff to maintain the detectors. The run time should only be dependent upon power sources, and not restricted by consumables. The level of maintenance/support required per annum should not exceed 12 hours.

Cost. The quantity of detectors required for this user group is difficult to determine. It is assumed that TCPs will be strategically located on either side of the plume. TCPs will likely be established based upon traffic patterns rather than located for monitoring purposes. This user group will, however, be relatively small. It is assumed that the initial cost should not exceed $7500 per unit and the annual cost should not exceed $500 per unit.

6.2.3 Physical Requirements

The physical requirements of the TCP user group are based upon the assumption that each TCP responder will store the detection equipment in their vehicle, but will be required to remove the detector from the vehicle during a chemical event. The requirements for size, weight, and transportability are fairly inflexible.

Size. The size constraints are critical for this user group because the detection equipment must be transportable on vehicles with limited space available, and also must be one-man portable. The most likely vehicle under consideration is the standard police car. Detectors used by the TCP responders should be small enough to fit in the trunk of a vehicle while in a transport case. Given this, the equipment size should be less than 0.03 cubic meters (i.e., small suitcase).

Weight. The detection equipment should not require a vehicle to be transported. The detector should be one-man portable (< 23 kg).

6.2.4 Special Requirements

Equipment adequate for use by emergency responders performing traffic control duties should not require any special licensure (i.e., Nuclear Regulatory Commission permit). The detection equipment should also operate on standard vehicle or battery power sources. This equipment should be intrinsically safe for transport, operation, and storage.

6.2.5 Assessment

The assessment for Mission 2 revealed that none of the detectors surveyed meet all of the requirements for TCP personnel (based upon assumptions described). Detectors that meet a high percentage of the requirements include detectors A47 (Parametric M923 and M626) and A35 (SAW MINICAD MKII). These detectors do not, however, have the required sensitivity or selectivity. As in Use Concept 1 the detectors with the appropriate sensitivity are too expensive, complex, and usually designed for a laboratory environment. Note that the detector that matches the highest percentage of requirements is not necessarily the optimal choice because some requirements may be essential to the mission. For example, Detector A25 (M9 Paper) matches a high percentage of the requirements, but is of little use to this mission because it cannot detect chemical agents in the required physical state.

Tables 12, 13, and 14 indicate with a check mark the detectors described in Volume 2 that meet that selected requirement. An "X" indicates that the selected requirement is not met. Shaded areas indicate that vendor verification was not obtained. Blank cells indicate that information is not currently available. A detector index can be found in Appendix A.

Table 12. Mission 2: Point Detectors Assessment

DETECTOR	Agents Detected	Alarms	Sensitivity	Selectivity	Response time	Start up time	Ease of ops.	Maintainability	Cost initial	Cost yearly	Size	Weight	Transportable	Regulations	Interface
A1	✓	✓	X	✓	X	X	X	✓	X		✓	✓	✓	X	
A2	X	✓	X	X	X	X	✓	✓	X		✓	✓	✓	X	X
A3	✓		X	X	✓	✓	✓	✓	X		✓	✓	✓	X	✓
A4	✓	✓	X	✓	X	X	X	✓			✓	✓	✓	X	✓
A5	✓	✓	X	X	✓	X	X	✓	X		✓	✓	✓	X	✓
A6	✓	✓	X	X	✓	X	X	✓	✓		✓	✓	✓	X	✓
A7	✓	✓	X	X	X	X	X	✓	X		✓	✓	✓	X	✓
A8	✓	✓	X	X	X	X	X	✓	X		✓	✓	✓	X	✓
A9	✓	✓	✓	X	✓	X	✓	✓	X	✓	✓	✓	✓	X	✓
A10	✓	✓	X	X	X	X	X	✓			✓		✓	X	✓
A11	✓	✓	X	X	X	X	X	✓			✓	✓	✓	X	✓
A12	✓	✓		X	✓		X	✓	X		X	X	X	X	✓
A13	✓		X	X	✓	X	✓	X	X	✓	✓	✓	✓	X	X
A14	✓	✓	X	X	✓	X	✓	✓	X	✓	✓	✓	✓	X	✓
A15	✓	X	X	X	✓		X	✓			✓	✓	✓	X	✓
A16	✓		X	X	✓		X	✓	X		✓	✓	✓	X	

DETECTOR	Agents Detected	Alarms	Sensitivity	Selectivity	Response time	Start up time	Ease of ops.	Maintainability	Cost initial	Cost yearly	Size	Weight	Transportable	Regulations	Interface
A17	✓	✓	X	✓	X	X	X	✓	X			✓	✓	X	✓
A18	✓	✓	X	✓	✓	X	X	✓	X		✓	✓	✓	X	✓
A19	X	✓	X	X	✓		X	✓	✓		✓	✓	✓	✓	✓
A20	X	✓	X	X	X		✓	✓	✓		✓	✓	✓	✓	✓
A21	✓	✓	X	✓			X	✓			X	✓	✓	✓	✓
A22	✓	✓	X				X	X			✓	✓	✓	X	X
A23	X	✓	X	X	✓		X	✓			✓	✓	✓	✓	✓
A24	X	X	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A25	X	X	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A26	X	X	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A27	✓	X	X	X	X	✓	✓	✓	✓	✓	✓	✓	✓		✓
A28	✓	X	X	✓	X	✓	X	✓	✓	✓	✓	✓	✓	✓	✓
A29	✓	X	X	X	X	✓	✓	X	✓	✓	✓	✓	✓	X	✓
A30	X	X	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓	✓
A31	X	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A32	✓	X	X	X		X	✓	✓			✓	✓	✓	✓	✓
A33	✓	X	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓	✓
A34	✓	✓	X	X	✓	X	X	✓	✓		✓	✓	✓	✓	✓
A35	✓	✓	X	X	✓	X	X	✓	✓		✓	✓	✓	✓	✓
A36	✓	✓	X	X	✓	X	X	✓				✓	✓	✓	✓
A37	✓	X	X	X	✓	✓	X	✓	✓	X	✓	✓	✓	✓	✓
A38	✓	✓	X	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓
A39	✓	✓	✓	✓	X		X	X	X		✓	✓	X	X	X
A40	✓	✓	X	✓	X	X	X	X	X	X	X	✓	✓	X	✓
A41	✓	X	✓	X	X		X	X			X	✓	✓	X	✓
A42	X	✓	X	X			X	✓				✓	✓	✓	✓
A43	✓		X		X		X	✓	X		X	✓	✓	✓	X
A44	✓	X	✓	✓	✓		X	X			✓	✓	✓		✓
A45	X		✓	✓	✓		X	X	X		X	X	X	✓	✓
A46	✓		✓	✓	X		X	X				✓	✓	✓	✓
A47	✓	✓	X		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A48	X	X	X	X	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	✓

Table 13. Mission 2: Standoff Detectors Assessment

DETECTOR	Agents detected	Alarms	Sensitivity	Selectivity	Response time	Start up time	Ease of ops.	Maintainability	Cost initial	Cost yearly	Size	Weight	Transportable	Regulations	Interface
B1	✓	✓	✓	✓	✓	X	X	X			X	✓	X	✓	X
B2	X		✓	✓	✓	X	X	X			X	✓	✓	✓	X
B3	✓		✓	✓	✓	X	X	X	X		X	X	✓	✓	X
B4	✓	✓	✓	✓	✓	X	X	X			X	X	✓	✓	✓
B5	X	✓	✓	X	✓	X	X	X	X		X	X	✓	X	✓

Table 14. Mission 2: Analytical Instruments Assessment

DETECTOR	Agents detected	Alarms	Sensitivity	Selectivity	Response time	Start up time	Ease of ops.	Maintainability	Cost initial	Cost yearly	Size	Weight	Transportable	Regulations	Interface
C1	✓	X	✓	✓	X	X	X	X					X	✓	X
C2	✓	X	✓	✓	X	X	X	X					X	✓	X
C3	✓	X	X	✓	✓	X	X	✓	X	X	X	X	X	✓	X
C4	✓	X	✓	✓	✓	X	X	✓	X		X	X	✓	✓	X
C5	✓	✓	✓	✓	X	X	X	X	X	X	X	X	X	✓	X
C6	✓	✓	✓	✓	X	X	X	X	X	X	X	X	X	✓	X
C7	✓	✓	✓	X	X	X	X	X			X	X	✓	X	X
C8	✓	✓	X	X	X	X	X	X			X	X	✓	X	X
C9	✓	✓	✓	✓	X	X	X	X				X	✓	X	✓
C10	✓	✓	✓	✓	X	X	X	X				✓	✓	X	✓
C11	✓	✓	X	✓	X	X	X	X	X	X	X	X	X	X	✓
C12	✓		✓	✓	X		X	X					X	✓	X
C13	✓	X	✓	✓		X	X	X	X		X	X	X	X	X
C14	✓	X	✓	✓	X	X	X	X	X	X	X	X	X	X	X
C15	✓	✓	✓	✓	X	X	X	X	X	X	X	X	X	X	X
C16	✓		✓	✓		X	X	X	X	X	X	X	X	X	X
C17	✓	X	✓	✓	X	X	X	X					X	X	X
C18	✓	X	X		X	X	X	✓				X	X	✓	✓
C19	X	X	X	✓	✓	X	X	✓	X		✓	✓	✓	X	✓
C20	X	✓	✓	✓	X	X	X	X				X	X	✓	✓
C21	✓	X	✓	✓	X	X	X	✓					✓	✓	✓

7.0 Conclusion

The objective of this study was to summarize and assess the applicability of CWA detection equipment to potential CSEPP off-post users. This report provides a basic methodology and the necessary technical information to assess CWA detection equipment. Two potential missions were analyzed to illustrate the assessment process. The missions included assumptions about the requirements of each user group. The two user groups analyzed included off-post decon personnel and TCP personnel.

The assessment of these two missions revealed that CWA detection equipment is not available that will fully meet the requirements of the user groups. Point detection equipment is generally not sensitive or selective enough to meet user requirements. Standoff detection equipment typically requires operators with technical backgrounds and is also very expensive. Analytical instruments are usually very large, extremely expensive, require sample preparation, do not respond in real time, and require operators who are technical specialists. It should be noted that this assessment did not account for onsite procedures, equipment, or limitations. Inclusion of these factors could affect the requirements of off-site user groups and the results of the equipment assessment.

This report contains information that will be useful for making educated decisions on detector suitability. The report should be viewed, however, as a starting point for decision-makers. Before making a final decision regarding the acquisition of a specific detector, decision-makers should consider on-post capabilities and should also contact manufacturers to obtain the most up-to-date information.

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** Product literature from the manufacturers listed in Volume 2 was also utilized.*

Appendix A

Index Name	Detector/Instrument Name
A1	Bruker IMS Point Chemical Detector (PCD)
A2	M8/M43, M8A1/M43A1, M8A1 Automatic Chemical Agent Alarm
A3	Chemical Agent Monitor (CAM), Improved Chemical Agent Monitor (ICAM)
A4	Environmental Vapor Monitor (EVM)
A5	Rapid Alarm and Identification Device-1 (RAID-1)
A6	Improved Chemical Agent Monitor – Advanced Portable Detector (ICAM-APD)
A7	Chemical Agent Monitor/Field Alarm Module (CAM/FAM)
A8	GID-3 Chemical Agent Detection System (M22)
A9	M90-D1 Chemical Warfare Agent Detector
A10	Phemtochem Ion Mobility Spectrometer, Model 110
A11	GI-MINI Miniature Chemical Warfare Detector/Monitor
A12	Chemical Agent Detection System II (CADS II)
A13	UC AP2C
A14	APACC Chemical Control Alarm Portable Apparatus (Model M266 E 10 002)
A15	Detalac Automatic Detector of Nerve Gas Agents
A16	Continuous Chemical Agents Sensor (CHASE)
A17	Type 1302 Multigas Monitor
A18	Type 1306 Toxic-Gas Monitor
A19	Toxic Gas Detector
A20	Improved Chemical Agent Detector (ICAD)
A21	Nerve Agent Immobilized-Enzyme Alarm and Detector (NAIAD)
A22	Ship Installed Chemical System (SICS Mk. 7 NHA)
A23	Automatic Liquid Agent Detector (ALAD) System
A24	M8 Chemical Agent Detector Paper, ABC-M8 VGH Chemical Agent Detector Paper and M8 Paper
A25	M9 Chemical Agent Detector Paper, M9 Paper
A26	Paper, Chemical Agent Liquid Detectors, 3-Way
A27	C2 Chemical Agent Detector Kit
A28	M18A2 Chemical Agent Detector Kit
A29	M256 Kit, M256A1 Kit
A30	M272 Water Testing Kit, M272 Chemical Agents Water Testing Kit, M272 Kit
A31	Nerve Agent Vapor Detector (NAVD)
A32	No 1 MK 1 Detector Kit Chemical Agent Residual Vapor Detector (RVD)
A33	Drager-tube Gas Detection System
A34	SAW MINICAD MKII
A35	CAA/2
A36	Photovac Microtip Handheld Air Monitor/Photo-ionization Detector
A37	IS-101
A38	MINIRAE Plus
A39	Miniature Chemical Agent Monitor (MINICAM)
A40	Scentograph Plus II with AID/RCD Detector
A41	Minitube Air Sampling System (MASS)
A42	Portable Odor Monitor
A43	Neotronics Olfactory Sensing Equipment (NOSE)
A44	MIRAN Sapphire

Index Name	Detector/Instrument Name
A45	No.1 Mark 1 Detector Kit Chemical Agent Residual Vapor (RVD)
A46	Mass-Spectrometer-on-Chip (MSOC) (“Handheld” Mass Spec, “Portable” Mass Spec)
A47	Pragmatic Model 923, Pragmatic Model 626
A48	SCX-20 VOC Monitor
B1	M21 Remote Standoff Chemical Agent Alarm, M21 Remote Sensing Chemical Agent Alarm (RSCAAL)
B2	The Air Sentry-FTIR
B3	Chemical Agent Alarm System
B4	Transform Spectrometer
B5	Laser Remote Detector
C1	Quantum 300
C2	Dycor Quadlink
C3	CUB 800
C4	API 365
C5	HP 5973 MSD
C6	HP 6890
C7	Automatic Continuous Air Monitoring System (ACAMS)
C8	Dual Flame Photometric Detector
C9	EKHO
C10	Photovac Snapshop Hand Held Gas Chromatograph
C11	Scentoscreen (Gas Chromatograph) with Argon Ionization Detector
C12	MM-1 Mobile Mass Spectrometer
C13	Viking Spectra Trak 572
C14	Saturn
C15	HP 2350 A Atomic Emission Detector
C16	Infrared Detector for Gas Chromatograph
C17	Trace Ultra High Sensitivity
C18	Type 1301 Gas Analyzer
C19	RAMAN Chemical Analyzer
C20	System 2000 Process NMR
C21	Absorption Air Sampling "Bubbler"

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CSEPP Chemical Detection Equipment Assessment Volume II

To

U.S. Army Chemical and Biological Defense Command (CBDCOM)

April 1998

TABLE OF CONTENTS

Introduction

Volume 2 of this report includes detailed information on the capabilities and limitations of known chemical detection equipment. The equipment reviewed and assessed for this effort are a representative sample of available items for each of the detection technologies described in section 3.0 of Volume 1. The information sheets contain descriptions of the detector technology used and specifications that will be useful for making educated decisions on detector suitability. Volume 2 should be used as a starting point for decision-makers. Before making a final decision regarding the acquisition of a specific detector, the decision-makers should contact the manufacturer to obtain the most up-to-date information regarding the detector.

As noted in Volume 1, Battelle attempted to verify the capabilities and limitations of the equipment listed in this report with the manufacturer. Although each manufacturer was contacted a minimum of three times, a significant percentage of the manufacturers chose not to respond. Appendix A includes the list of manufacturers who responded to the survey. In some cases, Battelle was asked by CSEPP to approximate the capabilities of equipment if the manufacturer failed to respond. *Information contained in the data sheets that is based upon Battelle approximations is* ***italicized***. Battelle approximations for a specific detector were based upon the characteristics of other detectors possessing similar characteristics. Several of the detectors that were initially identified for the assessment were not included in this report due to a lack of information or inapplicability. A list of detectors that were initially identified for the assessment but were not included in the report are included in Appendix B.

The characteristics of the equipment are categorized as operational, logistical, physical, and special. The equipment characteristics included in the information sheets are described in the following subsections. These subsections define each of the characteristics, and also describe the relevance of the characteristics to a potential user. These subsections serve as a guide to Volume 2.

Description

The subsections for the "Description" section are as follows:

Manufacturer. The manufacturer subsection contains the name, address, phone number, and point of contact for the detector manufacturer. Note that some equipment may have multiple manufacturers. This information will be of value to a user who is considering acquisition of detection equipment.

Technology. The technology subsection contains a brief description of the technology used by the detector. More detailed descriptions of the detector technologies are provided in Section 3.0. Examples of equipment technology include surface acoustic wave and ion mobility spectroscopy. Detectors that use the same technology will commonly possess similar capabilities and limitations. For example, certain technologies inherently require extensive technical backgrounds for operation (i.e., mass spectroscopy). Given the requirements of a specific user mission, all detectors based upon a certain technology may be excluded from consideration.

Type. The type subsection indicates if the detector is a commercial and/or military detector. Military detectors have generally been subjected to more extensive testing, including live chemical agent and severe environmental testing. Most commercial equipment has not been subjected to live chemical agent testing. The physical state of the sample that can be detected is also described in this section (i.e., vapor, aerosol, or liquid). A single detector will usually not detect chemical agents in all three physical states. As previously mentioned, off-post applications will require detection of the vapor state. The use of multiple detectors will typically require additional maintenance, training, skill level, cost, and space. Equipment that detects multiple chemical agents is usually more complex.

National Stock Number. If applicable, this subsection lists the national stock numbers that apply to the unit. National stock numbers apply only to equipment that is used by the military. This information will also be of value to a user who is considering acquisition of detection equipment.

Operational Parameters

The subsections for the "Operational Parameters" section are as follows:

Chemical Agent Detection. The chemical agent detection subsection lists which of the three target agents (GB, VX, and HD) can be detected. A user group should strive to acquire a single detector that detects all relevant chemical agents. The use of multiple detectors will typically require additional maintenance, training, skill level, cost, and space. Equipment that detects multiple chemical agents is usually more complex.

Sensitivity. The sensitivity subsection lists the lowest concentration of chemical agent that can be detected. Sensitivity limits are agent-dependent and also vary with environmental conditions. Sensitivities listed are usually determined under optimal conditions. Sensitivity is significant to the user because it is closely related to warning time. The warning time will increase as the detection limit of the detector decreases. The exact relationship between the two is uncertain due to the variability associated with chemical events. Equipment should detect chemical agents well below dangerous concentrations (below IDLH or TWA-8) in order to provide users enough time to take protective measures. The cost and complexity of detection equipment typically increases as its sensitivity decreases.

The sensitivity subsection also lists if the equipment possesses an audible or visual alarm. The type of alarm required will be dependent upon the mission. Users who may not have visual access to the equipment, such as traffic control personnel, will require audible alarms. Other users, such as decon personnel, may not desire an audible alarm due to the panic that casualties may experience.

Selectivity/Interferants/False Alarms. Selectivity is a measure of the instrument's ability to distinguish between varying compounds in a sample. An interferant is a compound that causes a detector to false alarm. The two types of false alarms are false positive and false negative. A false positive occurs when no chemical agent is present, but the detector still alarms. A false negative occurs when chemical agent is present, but the detector fails to alarm. A detector with poor selectivity will typically be prone to false alarms. Section 4.3 discusses interferants known to cause false alarms.

The tendency to false alarm is a highly undesirable characteristic. Personnel and civilians will respond to a false positive alarm as though it were a genuine detection of chemical agent. A false positive alarm will cause personnel and civilians to take all necessary emergency actions. The consequences of a false negative alarm are apparent. False alarms should be avoided as a matter of preserving public safety and maintaining public trust. To achieve negligible or zero false alarm rates may require detectors to employ sophisticated algorithms or electronics. Equipment that does not false alarm to non-battlefield interferants (as listed in section 4.3) is categorized as highly selective. Equipment that will false alarm to these interferants is categorized as not highly selective. Users should acquire equipment that is highly selective, or have control measures in place to deal with false alarms.

Response Time. Response time is the time it takes for a detector to collect a sample, analyze the sample, determine if a chemical agent is present, and provide feedback. Equipment may respond in real time, or response could take hours. Real time response is typically defined as within one minute. Response time is usually slow when detection limits are extremely low.

Response time is significant to the user because it is closely related to warning time. Warning time increases as response time decreases. Significant delays in response may not be acceptable in many cases. For example, delayed response could slow the decontamination of personnel so drastically that serious injury could incur as a result of additional exposure.

Start-Up Time. Start-Up Time is defined as the time required to setup and begin sampling with an instrument. Time is measured from the instant the instrument is removed from storage until the time the unit is able to provide analysis. Start-up time could range from several seconds to several hours depending upon the complexity of the equipment. Start-up time is significant to the user because it is closely related to warning time. Warning time increases as start-up time decreases. Start-up time is more critical to personnel involved with crisis management than it is to personnel involved with consequence management. Equipment with significant start-up times commonly require operators with technical backgrounds.

Logistical Parameters

The subsections for the "Logistical Parameters" section are as follows:

Ease of Operation. The ease of operation subsection defines the skill level and the training that is required for proper operation of the instrument. The skill level and training requirements are subjective characteristics of the equipment. The three levels of technical background, starting with the most advanced, are Technical Specialist, Technical Background, and No Technical Background. The Technical Specialist will generally have an advanced science degree (i.e., Chemistry, Engineering) and be able to interpret data acquired with analytical equipment. A Technical Specialist would also be capable of trouble shooting equipment problems and performing both regular and preventative maintenance. The Technical Specialist category may also be satisfactorily met if the user has a significant amount of laboratory or analytical experience. Technical Background is defined as someone who generally has an undergraduate degree in a technical field, a degree from a technical school, or 2 years experience operating electronic, laboratory or test equipment. This person should be able to trouble shoot minor problems with the instrument, and perform regular and preventive maintenance. A person with a technical background should be able to make inferences about a situation based on instrument readings. No Technical Background is a person who generally has a high school education and has minimal or no experience operating electronic, laboratory, or test equipment. The person is capable of following instructions written with technical language.

The two training levels are Formal Training required and No Formal Training required. Formal requires an instructor trained to teach operation, maintenance and interpretation of the detector output. The training may consist of classroom lectures with laboratory hands-on operation of the detector. No Formal Training means the user can operate the detector after reading the instructions or receiving an informal demonstration by someone familiar with the detector operation.

User groups must consider the skill level of their members and the time available for training when acquiring detection equipment. Most user groups will not be able to provide or maintain a technical support staff to operate the detection equipment. Given this, the technical skill level required to operate the equipment and the quantity of training required should be minimal. Simplicity generally decreases the time required to operate the detector, thereby freeing personnel for other essential operations. Some missions may provide a readily available training environment making the necessity for minimal training less of a concern (i.e., emergency service personnel are typically required to attend monthly training).

Maintainability/Supportability. The maintainability and supportability subsection defines the additional equipment, supplies and labor necessary to calibrate and ensure reliable operation of the instrument. A list of consumable materials used during operation and a list of waste generated from operation is provided in this section as well as the level of repairs. This subsection also addresses the run time of the equipment. Run time is typically dependent upon the power source and is usually not a limiting factor of the equipment. The run time of some equipment is restricted by consumables.

For most missions, maintainability and supportability are related to the ease of operation and the space claim. Equipment that requires extensive maintenance and support is typically complex and difficult to operate. Additional equipment and supplies also demand space in excess of that required by the detector and transport container. This space may not be available for some missions. Users should strive to acquire equipment that requires no additional components or supplies to ensure continued performance.

Cost. The cost parameter lists the initial cost and the approximated annual cost. The annual cost consists of the training cost, supportability cost, and maintenance cost. User groups should consider the total cost (initial plus annual) and the cost/benefit relationship when making an equipment acquisition decision. Cost is closely related to every other equipment characteristic. In general, cost will increase as sensitivity increases, as selectivity increases, as ease of operation increases, and as maintainability and supportability decrease. User groups should also consider the quantity of detectors that must be acquired when determining an appropriate cost limit.

Physical Parameters

The subsections for the "Physical Parameters" section are as follows:

Size. The size subsection lists the dimensions of the equipment. Size is typically related to transportability. The size requirements specified are influenced by the specific application. For missions in which the detector will be stored in the trunk of a police car, for example, space is limited due to other equipment that is required for daily operation of the officer. Users must also allow for transport containers.

Weight. The weight subsection lists the weight of the equipment. Weight is also related to transportability. If the equipment is required to be man portable, the weight should be less than 23 kg (50 lbs) to ensure operator safety. If the mission requires vehicle mounted detectors, for example, the weight capacity should be considered with respect to the transporting vehicle. Some equipment may require vehicle modification to withstand the additional weight.

Transportability. The transportability subsection defines the number of people and the type of equipment required to transport the detection equipment. The transportability requirement is categorized as man-portable, vehicle portable, or not portable. As previously mentioned, transportability is directly related to size and weight. The mission of the user group will determine the transportability requirements. For example, a decontamination crew may need to travel to various locations and then scan casualties at a considerable distance from a vehicle. This mission would require equipment that is man-portable. This subsection also describes any special storage requirements.

Special Requirements

The subsections for the "Special Requirements" section are as follows:

Regulations. The regulation subsection gives a description of any special licenses, training, or skill level requirements that are mandated to own, operate, or transport the instrument. User groups should strive to acquire equipment that is not affected by burdensome regulation. Detectors that utilize a radioactive source, for example, will require a NRC license and specialized training and maintenance.

Interface Requirements. The interface subsection lists the power source requirements and any auxiliary equipment necessary for effective operation of the detector. Detection equipment will sometimes require atypical power sources or additional equipment to operate. User groups should consider their available power sources and the cost of auxiliary equipment before making an acquisition decision. If the detector will be carried in a police car, for example, it would be beneficial to ensure that the detector can operate on 12 VDC vehicle power or batteries.

Safety. The special requirements section also addresses the operational safety of the equipment. The information sheets highlight equipment that is not considered to be intrinsically safe to operate. A detector that could be explosive in some environments, for example, is not considered to be intrinsically safe.

Point Detectors and Alarm

<u>A1 Detector Name</u>
BRUKER IMS POINT CHEMICAL DETECTOR (PCD)

<u>Description:</u>
Manufacturer
Bruker Saxonia Analytik, Germany

Technology
This is an IMS detection device that is designed to reject interferants through an advanced pattern recognition algorithm.

Type
- Military
- Detects *vapors*

National Stock Number
NA

<u>Operational Parameters:</u>
Agent Detection
Detects GB, VX, and HD.

Alarm
Audio and visual

Sensitivity
Detects GB, VX at 0.005 mg/m^3
Detects Mustards (All) at 0.02 mg/m^3

Selectivity/Interferants/False Alarms
Highly selective
No known interferants. Demonstrated to detect GB in the presence of many interferants. Less than one false alarm per 200 hours of operation.

Response Time
Responds in less than 2 minutes.

Start-Up Time
Less than 2 minutes

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability

CALIBRATION - *Required*
CONSUMABLES - *None*
WASTE GENERATED - *None*
REPAIRS – *By manufacturer only*

Cost
INITIAL COST - $12, 000
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
Less than 0.03 m^3

Weight
Less than 10 kg

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note this detector contains a sealed radioactive source*
REQUIRED LICENSES – *NRC for radioactive source*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS: - *None*

Interface Requirements
POWER SOURCES - No information available
AUXILIARY EQUIPMENT - No information available

A2 Detector Name
M8/M43, M8A1/M43A1, M8A1 AUTOMATIC CHEMICAL AGENT ALARM

Description:
Manufacturer
Intellitec (formerly Brunswick Corporation)
2000 Brunswick Lane
Deland, FL 32724
(904) 736-1700 (TEL)
(904) 736-2250 (FAX)

Technology
The M43A1 is an ionization product diffusion/ion mobility type detector. A pump continuously draws air through the internal sensor. As the air and agent molecules are drawn past a radioactive source, a small percentage are ionized by alpha-rays. As the air and agent ions are drawn through the baffle sections of the cell, the lighter and less stable air ions diffuse to the walls and are neutralized more quickly than the heavier and more stable agent ions. As a result, the collector senses a greater current when nerve agents are present compared to the current when only clean air is sampled. An electronic module monitors the current produced by the sensor and triggers the alarm when a critical threshold of current is reached.

Type
- Military
- Detects vapor

National Stock Number
M8A1 Alarm System - 6665-01-105-5623
M43A1 Detector - 6665-01-081-8140

Operational Parameters:
Agent Detection
Detects GB and VX.

Alarm
Yes – *audio and visual*

Sensitivity
Detects GB at 0.1-0.2 mg/m^3.
Detects VX at 0.4 mg/m^3.

Selectivity/Interferants/False Alarms
Not highly selective
The M8A1/M43A1 will false alarm to heavy concentrations of rocket propellant smoke, screening smoke, signaling smoke, engine exhausts, and whenever a nuclear blast occurs.

IMS detectors may give false readings when used in enclosed spaces or when sampling near strong vapor sources (i.e., In dense smoke). Some vapors known to give false readings are: aromatic vapors (perfumes, food flavorings, some aftershaves, cough lozenges, and menthol cigarettes (when vapors are exhaled directly into the nozzle)), cleaning compounds (disinfectants, methyl salicylate, menthol, etc.), Smokes and fumes (exhaust from some rocket motors, fumes from some munitions) and some wood preservative treatments (polychlorinated biphenyls (pcbs)) when in an enclosed space.

Response Time
Detection within 0.5 to 2 minutes.

Start-Up Time
< 30 minutes @ 25 C
< 1 hour @ -40 C

Logistical Parameters:
Ease of Operation
SKILL LEVEL - Technical Background
TRAINING - Formal training

Maintainability/Supportability
CALIBRATION - NA
CONSUMABLES - Battery, M273 Maintenance Kit
WASTE GENERATED - None under normal operation
- The 250 μci Of AM^{241} is collected by the U.S. Nuclear Regulatory Commission, at the end of useful life.

REPAIRS - Battery needs to be changed; M273 maintenance kit is used to change inlet dust filters and replace test paddles. *Other repairs by manufacturer.*

Cost
INITIAL COST - Current cost < $10,000/each, for 1,000 units
ANNUAL COST - Information not available

Physical Parameters:
Size
M43A1 Detector - 16.5 x 14 x 27.5 cm
M42 Alarm - 22.1 x 14.7 x 6 cm

Weight
M43A1 Detector - 3.4 kg
M42 Alarm - 1.9 kg

Transportability
Human and vehicle transportable - cannot be operated while moving

Special Requirements:

Regulations
INTRINSICALLY SAFE – *Note this detector contains a sealed radioactive source*
REQUIRED LICENSES - Nuclear Regulatory Commission license for 250 micro Ci radioactive source
MANDATORY TRAINING - Some training needed
MANDATORY SKILL LEVELS – *None*

Interface Requirements
POWER SOURCES - battery, vehicle 25 VDC and 110/220 VAC
AUXILIARY EQUIPMENT - System Components

- Up to five M42 alarms may be used per M43A1 detector and placed at locations remote from the detector.
- battery (BA3517/U)
- M42 Alarm
- M43A1 Detector
- power supplies (M10 and M10A1)

- Support Equipment
  - WD-1 or TT DR-8 cable is required to connect the M43A1 Detector to the M42 Alarm. A Winterization Kit (M253) is available for operation in cold climates. Various expendable supplies are required for routine operation and maintenance. Mounting hardware includes the M228 high profile and M182 low profile mounting kits.
  - The Maintenance Kit (M273) is available which provides 10 spare inlet dust filters and 10 test paddles. The test paddles contain agent simulant to provide confidence that the system is operating properly.
  - A kit (M293) is available which provides 20 spare dust filters for operations in very dusty environments. This kit supplements the standard M273 KIT.
  - A M10A1 power supply is available to power the M43A1 from AC mains power, either 110 V or 220 V. The M10A1 clamps to the bottom of the M43A1 and on the top of the BA3517/U battery. The battery provides automatic backup power in the event of a power failure. The battery can be connected directly to the M43A1 for operation.

A3 Detector Name
CHEMICAL AGENT MONITOR (CAM), IMPROVED CHEMICAL AGENT MONITOR (ICAM)

Description:

Manufacturer
Environmental Technologies Group, Inc.
Attn: Samuel D. Ankerbrandt
VP of Marketing
1400 Taylor Avenue
P.O. Box 9840
Baltimore, MD 21284-9840
(410) 321-5114 (TEL)
(410) 321-5200 (TEL)
(410) 321-5255 (FAX)

Technology
The CAM/ICAM detects vapors of chemical agents by sensing molecular ions of specific mobilities (time in flight) and uses timing and microprocessor techniques to reject interferences. The CAM and ICAM utilize ion mobility spectrometry technology to detect and discriminate between mustard and nerve vapors. The operator must select G or H mode when operating the CAM or ICAM. Thus, the CAM and ICAM cannot detect both types of agents simultaneously.

Type
- Military commercial
- Detects vapors

National Stock Number
Buzzer: 6665-01-394-9916
CAM system: 6665-01-199-4153
Battery: 6665-99-760-9742
Confidence sample: 6665-99-225-3523
ICAM: 6665-01-357-8502

Operational Parameters:

Agent Detection
Detects HD, GB, VX

Sensitivity
Responds to 0.1 mg/m^3 concentrations. (VX, HD)
Responds to 0.03 mg/m^3 concentrations. (GB)

Selectivity/Interferants/False Alarms
Not highly selective

The CAM may give false readings when used in enclosed spaces or when sampling near strong vapor sources (i.e., In dense smoke). Some vapors known to give false readings are: aromatic vapors (perfumes, food flavorings, some aftershaves, cough lozenges, and menthol cigarettes (when vapors are exhaled directly into the nozzle)), cleaning compounds (disinfectants, methyl salicylate, menthol, etc.), Smokes and fumes (exhaust from some rocket motors, fumes from some munitions) and some wood preservative treatments (polychlorinated biphenyls (pcbs)) when in an enclosed space.

Response Time
1 minute

Start-Up Time
Approximately 1 minute

Logistical Parameters:

Ease of Operation
SKILL LEVEL - CAM and ICAM can be operated as an additional duty by soldiers of any specialty (*Technical Background*)
TRAINING - Some training needed (*Formal Training*)

Maintainability/Supportability
CALIBRATION - The object to be monitored is approached, and the CAM is held one inch from the surface. As soon as any bar reading is detected, the soldier immediately backs away from the object, puts the protective cap on the nozzle, and waits for the CAM to clear down (back to a zero bar reading). The operator can then continue monitoring.
CONSUMABLES - Batteries, confidence samples
WASTE GENERATED - The CAM and ICAM contain a beta radioactive source licensed for use by the U.S. Nuclear Regulatory Commission (NRC) under Title 10 Code of Federal Regulations. NRC and local applicable regulations must be followed for storage, shipment, and disposal. You should never attempt to open either the CAM or ICAM case. a damaged CAM or ICAM should be immediately packaged in the original container and shipped to direct support maintenance. Batteries can present a hazard if mishandled, damaged, crushed, or burned.
REPAIRS - Weekly preventative maintenance checks and services are required to maintain the operational readiness of the CAM
- Depending upon usage
- Replacement of charcoal filter, once per mission (72 hours)
- Replacement of internal ICAM sieve pack, one nut and screw every 400 hours of operation.
- *Other repairs by manufacturer*

Cost
INITIAL COST - CAM - $7,500.00

- ICAM - $5,500.00

ANNUAL COST **–** No information available

<u>Physical Parameters:</u>

Size

39 X 8 X 14.5 cm

Weight

1.7 kg

Transportability

The CAM is human portable and operable on the move. A simple packing procedure is required before movement. When transporting the CAM, NRC regulations must be complied with since the CAM has a radioactive source.

<u>Special Requirements:</u>

Regulations

INTRINSICALLY SAFE **–** *Note this detector has a sealed radioactive source*
REQUIRED LICENSES **–** NRC for radioactive beta source
MANDATORY TRAINING - Some training is needed
MANDATORY SKILL LEVELS - *None*

Interface Requirements

POWER SOURCES:
- Operates on 1 internal 6V lithium-sulfur dioxide battery
- A CAM training battery assembly is available as a nonstandard alternate power source for use in training to allow the CAM to be powered by 4 alkaline D-cell batteries (BA3030/U) instead of the standard CAM battery

AUXILIARY EQUIPMENT - System Components
- buzzer
- carrying case with harness (for over the shoulder transport)
- confidence sample
- environmental cap (to protect the electrical connector)
- filtered nozzle assemblies
- nozzle protective cap and spare (sealed in a container in case of contamination)
- spare battery

- Support Equipment
  - Diagnostic Test Set (DTS)
  - audio and visual alarms

<u>A4 Detector Name</u>
ENVIRONMENTAL VAPOR MONITOR (EVM)

<u>Description:</u>
Manufacturer
Graseby Dynamics
Attn: Mr. Neil Bloomfield
10640 Main Street, Suite 200
Fairfax, VA 22030
(703) 218-0380 (TEL)
(703) 358-6470 (FAX)

Technology
GC capillary linked with IMS technology.

Type
- Military
- Detects vapors

National Stock Number
Stock number not yet assigned

<u>Operational Parameters:</u>
Agent Detection
Able to detect a wide range of warfare agents and precursors, including vapor mixtures such as phosphonates and ketones. Detects *GB, VX, and HD*

Alarm
Audio and visual

Sensitivity
Classified – *In the PPM range*

Selectivity/Interferants/False Alarms
Classified.
Highly selective
The GC should provide high selectivity, better than a stand alone IMS detector

Response Time
Classified - *Less than 2 minutes*

Start-Up Time
Less than 2 minutes

<u>Logistical Parameters:</u>
Ease of Operation

SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES – *Batteries*
WASTE GENERATED - *None*
REPAIRS – *Made by manufacturer only*

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

Physical Parameters:
Size
45 x 8 x 20 cm

Weight
3.5 kg

Transportability
Easily transportable, hand held

Special Requirements:
Regulations
INTRINSICALLY SAFE – *Note this detector has a sealed radioactive source*
REQUIRED LICENSES – *NRC for radioactive source*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - 6 V rechargeable battery.
AUXILIARY EQUIPMENT - None

A5 Detector Name
RAPID ALARM AND IDENTIFICATION DEVICE-1 (RAID-1)

Description:
Manufacturer
Bruker Instruments Inc.
ATTN: Dr. John Wronka
Manning Park
19 Fortune Drive
Billerica, MA 01821-3991
(508) 667-9580 (TEL)
(978) 667-5993 (FAX)

Technology
RAID-1 is a hand-held ion mobility spectrometer for the detection of CWA in the air and on surfaces.

Type (military, commercial and liquid, vapor, aerosol)
- Military use (detector in use by any military service worldwide):
- Detects, vapors, and aerosols and surface contamination

National Stock Number
No information available

Operational Parameters:
Agent Detection
Detects GB, VX, and HD.

Alarm
Audio and visual

Sensitivity
Detects GB at 0.01-0.03 mg/m^3.
Detects VX at 0.01-0.03 mg/m^3.
Detects HD at 0.07-0.13 mg/m^3.

Selectivity/Interferants/False Alarms
U.S. Army test data exist indicating potential problems with interferents.
Not highly selective
IMS detectors may give false readings when used in enclosed spaces or when sampling near strong vapor sources (i.e., In dense smoke). Some vapors known to give false readings are: aromatic vapors (perfumes, food flavorings, some aftershaves, cough lozenges, and menthol cigarettes (when vapors are exhaled directly into the nozzle)), cleaning compounds (disinfectants, methyl salicylate, menthol, etc.), Smokes and fumes

(exhaust from some rocket motors, fumes from some munitions) and some wood preservative treatments (polychlorinated biphenyls (pcbs)) when in an enclosed space.

Response Time
Detects GB in 40 seconds.
Detects VX in 40 seconds.
Detects HD in 10 seconds.

Start-Up Time
The normal set-up and warm-up time for the detector is 5 to 10 minutes. After long term storage, this warm-up time may increase to approximately 1 hours to set-up the RAID-1 and automatically purge the system to make it ready for operation. For long term storage, the RAID-1 is normally stored in aluminum coated plastic sealed bags and all gas inlets and outlets are closed by gas tight caps provided with the system.

Logistical Parameters:
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal Training required*

Maintainability/Supportability
CALIBRATION - No information available
CONSUMABLES - confidence sample, batteries, back flush filter, dust filter, internal filter, pumps, valve and circuit board modules
WASTE GENERATED - no information available
REPAIRS - Mean Time To Repair (Unit Level Maintenance): < 0.25 Hours

- Change the back flush filter every 2 days to some weeks of operation, charge or change the battery pack, change the dust filter and performing confidence check if required. Change the internal circuit filter approximately every 4-6 months of operations and change the pumps as required.
- *Other repairs by the manufacturer*

Cost
INITIAL COST - One detector - $16,580.00
ANNUAL COST - No information available

Physical Parameters:
Size
Base detector and battery: 40.5 x 18 x 20 cm

Weight
3 kg

Transportability
Operates on vehicles (on the move)

According to the manufacturer, the RAID-1 is ideal for mobile applications because it is lightweight, operates over a temperature range of -25°C to +50°C, requires low power consumption, does not require external heating or cooling, and needs no chemicals. In addition, the manufacturer claims the RAID-1 has shown the capability to reliably alarm to CWA in a background of 500 mg/m^3 of diesel fuel, 1, 5000 mg/m^3 of gasoline, and 5,000 to 10,000 mg/m^3 of exhaust from burning fuel. This property is critical for incorporating a detector into a motor vehicle where fuel and exhaust are important background agents. No modifications are necessary for mobile vehicle mounted operation

Stowed or transport configuration for the detector

Bruker provides MIL-SPEC transport case for transportation of the RAID-1 and all accessories. The case is 43.5 x 38 x 14.3 cm and includes a handle for easy transport as a "briefcase." The case includes compartments for the RAID-1, carrying strap, strap bags for filters and batteries, battery packs, back flush filter with storage cap, simulants, interface for remote display/data processing, power cable for connection to vehicle power supply, cable to connect several RAID-1 units in a network, and technical instructions.

Human portable

<u>Special Requirements:</u>

Regulations

INTRINSICALLY SAFE – *Note this detector contains a sealed radioactive source*
REQUIRED LICENSES – NRC for radioactive source
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements

POWER SOURCES - both lithium and rechargeable NiCd battery packs are available. size and weight depend on the operating time required. the minimum configuration is 12 VDC at 2.5 AHR. This configuration is 16 x 7 x 2.5 cm (Lithium) and 16 x 7 x 5 cm (Nicad) with a weight of 409 g and 909 g respectively. This results in 6-8 hours of operation. Longer operation is possible with either additional battery packs or larger battery packs. 72 hours of operation is possible with a battery pack that weighs under 5.4 kg. This corresponds to a total system weight (detector and batteries) of 8.2 kg for a 72 hour mission with no external power.

- Vehicle power is not limited to 28 VDC, with the current and voltage requirements of the RAID-1, the system may easily be connected to any vintage vehicle that uses either a 6 or 12 VDC electrical system. To operate from the vehicle power supply, a cable is provided to mate to the MIL-SPEC Cannon G connector on the RAID-1 interface module.

- Operation from AC power is through an AC powered DC power supply connected via the interface module. This power supply works from unregulated input of 110-240 VAC 50-60 Hz.

AUXILIARY EQUIPMENT - Interface Module (RS-22 to RS-422/485)

A6 Detector Name
IMPROVED CHEMICAL AGENT MONITOR-ADVANCED PORTABLE DETECTOR (ICAM-APD)

Description:
Manufacturer
Environmental Technologies Group, Inc.
Attn: Mr. Sam Ankerbrandt
1400 Taylor Avenue
P.O. Box 9840
Baltimore, MD 21284-9840
Telephone: (410) 339-3112 (410) 321-5114
Fax: (410) 321-5255

Technology
ICAM-APD is based on Ion Mobility Spectrometry and integrates ICAM components and ETG's commercial off the shelf components. The ICAM-APD simultaneously detects nerve and blister agents; has superior resistance to battlefield and collective protection interferents, and has a battery life of over 2 ½ days at ambient temperature.

ICAM-D will utilize the Improved Chemical Agent Monitor (ICAM) as its detection module. The ICAM is based on IMS technology. The detector module is a mechanical/electrical interface for the ICAM. It contains an electronics board with a microprocessor that decodes the ICAM's output.

Type
- Military
- Detects vapor, inhalable aerosols and liquid.

National Stock Number
ICAM - 6665-01-357-8502
BA5847 battery - 6135-01-090-5364
M10A1 power supply - 6665-01-093-2739

Operational Parameters:
Agent Detection
Detects GB, VX, and HD

Alarm
Audible and visible

Sensitivity
Detects VX at 0.1 mg/m^3
Detects GB at 0.1 mg/m^3
Detects HD at 0.1 mg/m^3

Selectivity/Interferants/False Alarms
Not highly selective
CAM/ICAM is known to false alarm to strong aromatic vapors, cleaning compounds, exhaust fumes and some wood preservatives.
IMS detectors may give false readings when used in enclosed spaces or when sampling near strong vapor sources (i.e., In dense smoke). Some vapors known to give false readings are: aromatic vapors (perfumes, food flavorings, some aftershaves, cough lozenges, and menthol cigarettes (when vapors are exhaled directly into the nozzle)), cleaning compounds (disinfectants, methyl salicylate, menthol, etc.), Smokes and fumes (exhaust from some rocket motors, fumes from some munitions) and some wood preservative treatments (polychlorinated biphenyls (pcbs)) when in an enclosed space.

Response Time
Detects VX in 10-30/5 seconds.
Detects GB in 5-30 seconds.
Detects HD in 5/5 seconds
Detects high concentration of these agents in <10 seconds.

Start-Up Time
Detector can be set up in a field environment in less than 10 minutes. After long term storage in less than 20 minutes. Operator inserts ICAM into detector module, installs a new charcoal filter and turns on system. System will self-test and acquire reference. Operator then removes cap from ICAM and latches backflush adapter.

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION – *Required, comes with confidence sample*
CONSUMABLES - Charcoal canister
- Sieve pack
- Confidence samples

WASTE GENERATED – *None*

REPAIRS - Mean Time To Repair (Unit Level Maintenance) - 0.1 Hours
- Mean Time To Repair (Ids Level Maintenance) -.5 Hours
- No depot level maintenance is required
- Replacement of charcoal filter, once per mission (72 hours)
- Replacement of used gas mask filter, once per mission
- Replacement of internal ICAM sieve pack, one nut and screw every 400 hours of operation
- 3 minutes is required for routine service and operator tests for each accumulated operating time of 12 hours
- *Other repairs by manufacturer*

Cost
INITIAL COST - One detector - $7,047.00
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
16 X 13.5 X 36 cm

Weight
<5.5 KG including batteries

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note this detector has a sealed radioactive source*
REQUIRED LICENSES – *NRC for radioactive source*
MANDATORY TRAINING - No information available
MANDATORY SKILL LEVELS - No information available

Interface Requirements
POWER SOURCES - 5 V supply from 115/230 VAC
- 24-32 VDC input
- 1 to 4 lithium batteries BA-5847/U, 28 hour life @ 70°F
- Power supply M10A1

DC power
- A battery pack consisting of standard U.S. Army batteries will be selected. ETG has several candidate batteries under consideration. ETG is committed to a total weight less than 2.7 kg of the power supply. NICD rechargeable batteries will be used if a temperature compromise can be agreed upon.

Vehicle Power
- The power input to the detector module will accept 10 to 32 VDC. Cable adapters including vehicle power can be provided. Input sensing is automatic.

AC Power
- The detector module will accept 115/230 VAC. Cable adapters can be provided. Input sensing is automatic.

AUXILIARY EQUIPMENT - No information available

A7 Detector Name
CHEMICAL AGENT MONITOR/FIELD ALARM MODULE (CAM/FAM)

Description:
Manufacturer
Graseby Dynamics
Attn: Mr. Neil Bloomfield
10640 Main Street, Suite 200
Fairfax, VA 22030
(703) 218-0380 (TEL)
358-6470 (FAX)

Technology
The CAM/FAM utilizes the fielded CAM with the field alarm module (FAM) as a remote sentry alarm designed to offer a remote display/alarm feature. The FAM also automatically switches the CAM between nerve and blister agent modes. The CAM utilizes Ion Mobility Spectrometry (IMS) principles. The FAM is electronic. It uses serial data from the rear socket of the CAM, to which it is connected by a telephone cable.

The CAM/FAM uses IMS technology. Major enhancements include, but are not limited to, significantly improved storage/startup characteristics, greatly increased sieve life, and simplified logistics support

Type
- Military use (detector in use by any military service worldwide):
- Detects vapor, inhalable aerosol, and liquid.

National Stock Number
6665-99-087-4539 (NATO)

Operational Parameters:
Agent Detection
Detects GB, VX, and HD

Alarm
Audio and visual

Sensitivity
Detects GB, VX, and HD at 0.1 mg/m^3.
Some sources list sensitivity as classified

Selectivity/Interferants/False Alarms
Not highly selective
CAM/ICAM is known to false alarm to strong aromatic vapors, cleaning compounds, exhaust fumes and some wood preservatives.

IMS detectors may give false readings when used in enclosed spaces or when sampling near strong vapor sources (i.e., In dense smoke). Some vapors known to give false readings are: aromatic vapors (perfumes, food flavorings, some aftershaves, cough lozenges, and menthol cigarettes (when vapors are exhaled directly into the nozzle)), cleaning compounds (disinfectants, methyl salicylate, menthol, etc.), Smokes and fumes (exhaust from some rocket motors, fumes from some munitions) and some wood preservative treatments (polychlorinated biphenyls (pcbs)) when in an enclosed space.

Response Time
Classified – *Less than 2 minutes*

Start-Up Time
Set-up and start-up time is ~ 2 minutes.

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING - *Some*

Maintainability/Supportability
CALIBRATION - No routine calibration is needed
CONSUMABLES - Battery
- Sieve pack assembly
- Confidence samples
- Filtered nozzle package assembly

WASTE GENERATED - None

REPAIRS - Mean Time To Repair (Unit Level Maintenance) – 2500-4500 Hours
- Mean Time To Repair (IDS Level Maintenance) – 2500-4500 Hours
- Change battery every 10 hours; replacement of internal CAM sieve pack
- 15 minutes per 10 hour mission is required for routine service and operator tests for each accumulated operating time
- *Other repairs by manufacturer*

Cost
INITIAL COST - CAM - $9,500
- FAM - $3,500
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
CAM/FAM - 50 x 13.5 x 20.5 cm
FAM ONLY - 16.4 x 16 x 9.7 cm
FAM (INCLUDING CASE AND ACCESSORIES) - 22 x 31 x 14 cm

Weight
CAM/FAM - 2 kg
FAM ONLY - 1.4 kg
FAM (INCLUDING CASE AND ACCESSORIES) - 2.8 kg

Transportability
Human portable
Hand carried

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note this detector has a radioactive source*
REQUIRED LICENSES – *NRC for radioactive source*
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES - 1 Internal 2-Cell 6v Lithium-Sulfur Dioxide Battery

DC power
- 4 alkaline ' D' cell batteries

Vehicle Power
- A, DC/AC converter is required

AC Power
- May be powered by an AC/DC converter, 6 V

AUXILIARY EQUIPMENT - System Components - the items below are all contained in a carrying case that can attach to the CAM carrying bag.
- EMP unit
- FAM unit
- Rain shield cap
- Reel of field telephone cable (30 meters)
- Audio and visual alarms

A8 Detector Name
GID-3, CHEMICAL AGENT DETECTION SYSTEM

Description:
Manufacturer
Graseby Dynamics
Attn: Mr. Neil Bloomfield
10640 Main Street, Suite 200
Fairfax, VA 22030
(703) 218-0380 (TEL)
(703) 358-6470 (FAX)

Technology

Uses Ion Mobility Spectrometry (IMS) technology to give a local and remote visual and audible alarm; operate continuously with a quick response and cleardown; and indicate the identity of nerve, blister, blood, choking and other agents. It is the advancement of the GID-2 unit, and is significantly smaller and lighter than the GID-2 unit.

Type
- Military
- Detects vapor and aerosol

National Stock Number
- Not yet assigned
- BA5590/U battery - 6135-01-036-3495

Operational Parameters:
Agent Detection
- Detects GB, VX, and HD.

Alarm
Audible and visual

Sensitivity
- - Detects GB at 0.08-0.12 mg/m^3.
  - Detects VX at 0.03-0.05 mg/m^3.
  - Detects HD at 1.80-2.20 mg/m^3.

Selectivity/Interferants/False Alarms
Not highly selective
IMS detectors may give false readings when used in enclosed spaces or when sampling near strong vapor sources (i.e., In dense smoke). Some vapors known to give false readings are: aromatic vapors (perfumes, food flavorings, some aftershaves, cough lozenges, and menthol cigarettes (when vapors are exhaled directly into the nozzle)), cleaning compounds (disinfectants, methyl salicylate, menthol, etc.), Smokes and fumes

(exhaust from some rocket motors, fumes from some munitions) and some wood preservative treatments (polychlorinated biphenyls (pcbs)) when in an enclosed space.

Response Time
- Detects GB in 15 seconds.
- Detects VX in 120 seconds.
- Detects HD in 30 seconds.

Start-Up Time
- Designed to achieve a start-up time of less than 60 minutes at 60°C, normally 3 to 5 minutes

Logistical Parameters:
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING - Operation of GID-3 is extremely simple. A user with appropriate NBC training would be required to undergo a four-hour net session. (Formal Training Required)

Maintainability/Supportability
CALIBRATION – *Comes with confidence sample*
CONSUMABLES - Particulate filter; molecular sieve after 2000 hours
WASTE GENERATED - No information available
REPAIRS - Functional check with confidence tester; articulate filter on inlet may require replacement after use in dusty conditions. *Other repairs by the manufacturer.*

Cost
INITIAL COST - $10-12K (subject to quantity)
ANNUAL COST - No information available

Physical Parameters:
Size
15 x 13 x 23 cm

Weight
4.5 kg

Transportability
- Common Carrier And Mission/Field Transport (Non-Operating*)*: The GID-3 is primarily designed for operation within an armored fighting vehicle, in accordance with this role the detector and mountings have been designed to meet the following standards:

- Stowed Or Transport Configuration For The Detector: The GID-3 is designed for intallation in vehicles. A commercial standard packing is employed for delivery.
- Portable

Special Requirements:

Regulations

INTRINSICALLY SAFE – *Note this detector contains a sealed radioactive source*
REQUIRED LICENSES - *NRC for radioactive source*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements

POWER SOURCES - 24 VDC battery BA5590/U, one required, 15 hour life @ 70°F; power supply provided with detector
- DC Power – a range of primary and secondary battery supplies may be used.
- Vehicle Power - designed to operate from a nominal 24 Volt vehicle supply as specified in DEF-STAN 61-05.
- AC Power – can be powered from an external AC power source by the use of an AC to DC converter.

AUXILIARY EQUIPMENT - System Components
- Detector
- Remote alarm unit

<u>A9 Detector Name</u>
M90-D1 CHEMICAL WARFARE AGENT DETECTOR

<u>Description:</u>
Manufacturer
Sensor Applications, Inc.
Representing Envronics Oy
Attn: Mr. Richard C. Krahe, Program Manager
737 Walker Rd., Suite 1
Great Falls, VA 22066
(703) 759-6000 (TEL)
(703) 759-6867 (FAX)

Technology
An aspiration condenser type IMS detector combined with an advanced signal pattern recognizing method, supported by a semiconductor sensor, and semiconductor cell.

Type
- Military
- Detects vapor, inhalable aerosol, and liquid if vapors are present.

National Stock Number
BA5598/U battery: 6135-01-034-2239

<u>Operational Parameters:</u>
Agent Detection
Detects GB, VX, and HD

Alarm
Audio and visual

Sensitivity
Detects GB at 0.08-0.12 mg/m^3.
Detects VX at 0.03-0.05 mg/m^3.
Detects HD at 1.80-2.20 mg/m^3.

Selectivity/Interferants/False Alarms
Not highly selective
U.S. Army test data exist indicating potential problems with gasoline and diesel exhausts.
False alarm rate: less than one per 24 hours of operation.

Response Time
Detects GB in 5 seconds.
Detects VX in less than 10 seconds
Detects HD in less than 10 seconds

Start-Up Time
Automatic start-up time 5 minutes.
In field environment – 6 minutes
After long-term storage – it is recommended to let the detector "sun" for 5 to 10 minutes before live agent exposure.

<u>Logistical Parameters:</u>

Ease of Operation
SKILL LEVEL - Technical background
TRAINING - Only a basic user's training course is necessary to operate the detector. (Formal Training Required)

Maintainability/Supportability
CALIBRATION - No information available
CONSUMABLES - Batteries
- Inlet tube
- External micro filter
- Inside filter
- Test sample kit

Consumable Items Of The Standard Accessories Kit:
- M90-BC carrying bag
- M90-NB NICD battery
- M90-IT2 Inlet Tube
- M90-MF External Micro Filter
- M90-TS Test Sample Kit
- M90-IF Inside Filter
- M90-FT Filter Removal Tool

WASTE GENERATED - NONE
REPAIRS - Mean Time To Repair (Unit Level Maintenance): 0.17 To 0.25 Hours
- Mean Time To Repair (Ids Level Maintenance): 1 To 1.15 Hours

MAINTENANCE NEEDS - Replace internal dust filter and external dust filter as required by bit
- Replace NICD batteries every 8 hours
- Replace Semiconductor Cell Every 1500 Hours
- Maintenance Ratio (Unit Level Maintenance) 0.00015 Mmh
- Maintenance Ratio (IDS Level Maintenance) 0.0006(2/3000)
- 10-15 minutes required for routine service and operator tests for each accumulated operating time of 12 hours.

Cost
INITIAL COST - $16,500 with standard accessory kit
ANNUAL COST - $100/year and $1,100 per training class

<u>Physical Parameters:</u>

Size
30 x 10.5 x 28 cm

Weight
4.7 kg

Transportability
Human portable

Special Requirements:

Regulations
INTRINSICALLY SAFE – *Note this detector contains a sealed radioactive source*
REQUIRED LICENSES – *NRC for a radioactive source*
MANDATORY TRAINING - Operator Maintenance Manual
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - Can be powered by external power supply
- Battery BA5598/U, One Required, 17 Hour Life @ 70°F
- Power Supply Provided With Detector
- The M90 Battery Box will hold two BA5598/U's, however, only one is connected electrically
- DC power – the types of batteries used are:
    - The M90-NB (NiCD) life of 8 hours
    - The M90–LB (lithium battery)
    - The M90–MB (magnesium battery)
    - All connections are the same.
- Vehicle power
    - The M90-VP1/C vehicle power supply uses a standard cigarette lighter. It uses 10 to 32 VDC. A PRC-25 box is used. A multi-purpose connector is used to connect to the M90.
- AC power
    - M90-MP1 main 5 power supply: 110/220 VDC. 46 x 245 x 111 mm; 2.2 kg. Connection is similar to the M90-NB.

AUXILIARY EQUIPMENT - Vehicle Mounting Pack
- Shelter Mounting Pack

<u>A10 Detector Name</u>
PHEMTOCHEM ION MOBILITY SPECTROMETER, MODEL 110

<u>Description:</u>
Manufacturer
PCP Inc.
Attn: Martin J. Cohen, Pres.
2155 Indian Road
W. Palm Beach, FL 33409-3287
(800) 637-5307 (TEL)
(800) 637-5307 (FAX)

Technology
Ion Mobility Spectrometry

Type
- Commercial
- Detects *vapors and aerosols*

National Stock Number
NA

<u>Operational Parameters:</u>
Agent Detection
Detects HD, GB, and VX.

Alarm
Audio and Visual

Sensitivity
Approximately 1 ppb by volume

Selectivity/Interferants/False Alarms
Not highly selective
IMS detectors may give false readings when used in enclosed spaces or when sampling near strong vapor sources (i.e., In dense smoke). Some vapors known to give false readings are: aromatic vapors (perfumes, food flavorings, some aftershaves, cough lozenges, and menthol cigarettes (when vapors are exhaled directly into the nozzle)), cleaning compounds (disinfectants, methyl salicylate, menthol, etc.), Smokes and fumes (exhaust from some rocket motors, fumes from some munitions) and some wood preservative treatments (polychlorinated biphenyls (pcbs)) when in an enclosed space.

Response Time
Less than 2 minutes

Start-Up Time
Approximately 30 minutes

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING –Formal training

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES - *Batteries*
WASTE GENERATED - None
REPAIRS – *By the manufacturer*

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
Sensor - 32 x 18 x 25 cm
Gas Supply - 32 x 18 x 25 cm
Battery additional

Weight
> 14 kg

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note this detector contains a sealed radioactive source*
REQUIRED LICENSES - General license for 10 millicurie internal beta source
MANDATORY TRAINING - No information available
MANDATORY SKILL LEVELS - No information available

Interface Requirements (power sources, auxiliary equipment)
POWER SOURCES - AC power, average 70 watts
- Battery powered

A11 Detector Name
GI-MINI MINIATURE CHEMICAL WARFARE DETECTOR/MONITOR
(Prototype, not yet available)

Description:
Manufacturer
Graseby Dynamics
Attn: Mr. Neil Bloomfield
10640 Main Street, Suite 200
Fairfax, VA 22030
(703) 218-0380 (TEL)
(703) 358-6470 (FAX)

Technology
Ion Mobility Spectroscopy

Type
- Military
- Detects *vapors and aerosols*

National Stock Number
No information available

Operational Parameters:
Agent Detection
Detects HD, GB and VX

Alarm
Network Remote Alarm

Sensitivity
Classified – *Low PPMs*

Selectivity/Interferants/False Alarms
Classified
Not highly selective
IMS detectors may give false readings when used in enclosed spaces or when sampling near strong vapor sources (i.e., In dense smoke). Some vapors known to give false readings are: aromatic vapors (perfumes, food flavorings, some aftershaves, cough lozenges, and menthol cigarettes (when vapors are exhaled directly into the nozzle)), cleaning compounds (disinfectants, methyl salicylate, menthol, etc.), Smokes and fumes (exhaust from some rocket motors, fumes from some munitions) and some wood preservative treatments (polychlorinated biphenyls (pcbs)) when in an enclosed space.

Response Time
Classified – *Less than 2 minutes*

Start-Up Time
No information available – *Less than 5 minutes*

Logistical Parameters:
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING - Requires minimal training

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES - *Batteries*
WASTE GENERATED - *None*
REPAIRS – *Made by manufacturer only*

Cost
INITIAL COST – Prototype stage
ANNUAL COST - No information available

Physical Parameters:
Size
18 x 4 x 6 cm

Weight
~0.5 kg

Transportability
Easily transportable worn on belt

Special Requirements:
Regulations
INTRINSICALLY SAFE – *Note this detector contains a sealed radioactive source*
REQUIRED LICENSES – *NRC for radioactive source*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES – *Battery powered*
AUXILIARY EQUIPMENT – No information available

<u>A12 Detector Name</u>
CHEMICAL AGENT DETECTION SYSTEM II (CADS II)

<u>Description:</u>
Manufacturer
Scientific Instrumentation Limited (SIL)
2233 Hanselman Avenue
Saskatoon, Saskatchewan S7L 6A7
Canada
(306) 244-0881
(306) 665-6263

Technology
Provides user with a dual use for the CAM; that of a monitor and that of a remote point source detector. CADS II utilizes RF communication technology to facilitate real-time remote detection of chemical warfare agents using the IMS based CAM.

Type
- Military
- Detects vapors and aerosols

National Stock Number
NSN 6665-21-912-5316

<u>Operational Parameters:</u>
Agent Detection
Detects GB, HD, and VX

Alarm
Audio and visual

Sensitivity
The CAM deployed in the CADS II network detects chemical warfare agent vapors below the level for which masking is required.

Selectivity/Interferants/False Alarms
Not highly selective
The CAM may give false readings when used in enclosed spaces or when sampling near strong vapor sources (i.e., In dense smoke). Some vapors known to give false readings are: aromatic vapors (perfumes, food flavorings, some aftershaves, cough lozenges, and menthol cigarettes (when vapors are exhaled directly into the nozzle)), cleaning compounds (disinfectants, methyl salicylate, menthol, etc.), Smokes and fumes (exhaust from some rocket motors, fumes from some munitions) and some wood preservative treatments (polychlorinated biphenyls (pcbs)) when in an enclosed space.

Response Time
The CADS II updates the CCU display and alarm status every four to eight seconds in a bar format identical to that used for the CAM.

Start-Up Time
No information available

Logistical Parameters:

Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING - Training on set-up and operation of the CADS II system takes two hours.

Maintainability/Supportability
CALIBRATION – *Required, for CAM unit*
CONSUMABLES - *None*
WASTE GENERATED - *None*
REPAIRS – *Factory repair of CAM unit*

Cost
INITIAL COST - kit, NSN 6665-21-912-5316 - $47,100
- Central Control Unit (CCU) - $7000
- Sensor Station Interface (SSI) - $1500
- R.F. Transceiver - $2000
- Solar power system - $1700
- Land Sensor Station (LSS) - $550

ANNUAL COST – No information available

Physical Parameters:

Size
Kit, NSN 6665-21-912-5316 - 91 x 123 x 107 cm shipping
CCU – 25 x 43 x 15 cm
LSS – 23 x 104 x 162.5 cm
Solar panels - 61 x 107 x 7.5 cm

Weight
KIT, NSN 6665-21-912-5316 - 545 kg shipping
CCU – 27 kg
LSS – 16 kg
Solar Panels – 18 kg
Battery – 23 kg

Transportability
Portable, no special tools required for set-up allowing for easy assembly and disassembly in mobile military operations.

Special Requirements:

Regulations

INTRINSICALLY SAFE – *Note this detector contains a sealed radioactive source*
REQUIRED LICENSES – *NRC for radioactive source in the CAM*
MANDATORY TRAINING - No information available
MANDATORY SKILL LEVELS - No information available

Interface Requirements
POWER SOURCES - 110 or 22O VAC
24 VDC

The CADS II can be used in three possible combinations:

1. The LSS can be connected to the CCU with up to 1000 meters of cable. In this mode, power is supplied to the LSS by the CCU.

2. The LSS can be connected to the CCU with up to 3000 meters of light cable for serial data transmission. In this mode, power is supplied to the LSS by a solar cell with a rechargeable battery backup.

3. The LSS may communicate with the CCU using radio transmissions at distances up to 4000 meters. In this mode power is provided by a solar cell with rechargeable battery backup.

AUXILIARY EQUIPMENT - No information available

A13 Detector Name
UC AP2C

Description:
Manufacturer
Proengin SA
Attn: Mr. Fernand Nerbonne
Export Mngr., Military Dept.
3 Rue De L'industrie
78210 Saint Cyr L'ecole
France
33 130 584734 (TEL)
33 130 589351 (FAX)
697 113F (TELEX)

Technology
Flame Photometry

Type
- Detects vapors, aerosols, and liquids

National Stock Number
6665-14-475-1207

Operational Parameters:
Agent Detection
Detects GB, VX, and HD
Alarm audio and visual

Sensitivity
Detects GB 0.010 mg/m^3
Detects VX 0.016 mg/m^3
Detects HD 0.42 mg/m^3

Selectivity/Interferants/False Alarms
Not highly selective
Flame Photometric systems are known to false alarm to sulfur and phosphorous compounds. Detects malathion. Detects SO_2 when near a running motor.

Response Time
2 seconds

Start-Up Time
1 to 2 minutes between 0 C and 50 C

Logistical Parameters:

Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION – Every 1,000 hours of operation
CONSUMABLES – Lithium battery, and a refillable hydrogen unit
WASTE GENERATED - None
REPAIRS – No information available

Cost (initial cost, maintenance cost, supportability cost, training cost)
INITIAL COST – AP2C detector $8,250
– UC AP2C $10,000
ANNUAL COST - $700 every 1,000 hours of operation

Physical Parameters:
Size
39 x 8.6 x 14 cm

Weight
2 kg including battery and hydrogen storage device

Transportability
Human portable

Special Requirements:
Regulations
INTRINSICALLY SAFE – *Note this detector produces a flame and contains a hydrogen gas pack*
REQUIRED LICENSES - None
MANDATORY TRAINING – Basic training for some maintenance people
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES - 19 VDC – 32 VDC external power supply
AUXILIARY EQUIPMENT - No information available

A14 Detector Name
APACC CHEMICAL CONTROL ALARM PORTABLE APPARATUS (MODEL M266 E 10 002)

Description:
Manufacturer
Proengin SA
Attn: Mr. Fernand Nerbonne
Export Mngr., Military Dept.
3 Rue De L'industrie
78210 Saint Cyr L'ecole
France
33 130 584734 (TEL)
33 130 589351 (FAX)
697 113F (TELEX)

Technology
Flame Photometry

Type
- Military
- Detects vapor, inhalable aerosol, and liquid

National Stock Number
6665-14-460-2543

Operational Parameters:
Agent Detection
Detects GB, VX, and HD.

Alarm
Audio and visual

Sensitivity
Detects GB at 0.01 mg/m^3
Detects VX at 0.015 mg/m^3
Detects HD at 0.4 mg/m^3

Selectivity/Interferants/False Alarms
Not highly selective
Flame photometric systems are known to false alarm to sulfur and phosphorous compounds. Detects malathion. Detects SO_2 when near a running motor.

Response Time
Detects GB in 2 seconds at 2.75 mg/m^3
Detects VX in 2 seconds at 2.75 mg/m^3

Detects HD in 2 seconds at 2.75 mg/m^3

Start-Up Time
If temperature is > 0°C, start up time is 2 minutes
If temperature is < 0°C, start up time is 10 minutes maximum

Logistical Parameters:
Ease of Operation
SKILL LEVEL – No technical background
TRAINING – 1 hour basic training

Maintainability/Supportability
CALIBRATION – Every 1,000 hours of operation
CONSUMABLES - Battery for portable version, and refillable hydrogen cartridges
WASTE GENERATED - None
REPAIRS - Mean Time To Repair (Unit Level Maintenance) – 0.1 Hours
- Mean Time To Repair (Ids Level Maintenance) – 0.7 Hours
- Maintenance ratio (unit level maintenance) – 0.0001 mmh^3/op. Hr.
- Maintenance ratio (IDS level maintenance) – 0.0007 mmh^3/op. Hr replace circulator every 1,000 hours
- Clean optical part and burner every 5,000 hours
- Replace chopper motor every 5,000 hours
- 3 minutes are required for routine service and operator tests for each accumulated operating time of 12 hours
- Integrated auto-test for first level of maintenance, automatic diagnostic box for second level, computerized test bench for third level. Change of battery for portable version. Routine servicing of hydrogen cartridges. Shelf life of 10 years

Cost
INITIAL COST - One detector - $11,250
ANNUAL COST - $700 every 1,000 hours of operation.

Physical Parameters:
Size
42 x 8.6 x 14 cm

Weight
2.2 kg including battery and hydrogen pack.

Transportability
Human portable

Special Requirements:
Regulations

INTRINSICALLY SAFE – *Note this detector produces a flame and contains a hydrogen gas pack*
REQUIRED LICENSES - None
MANDATORY TRAINING – Basic training of some people for maintainence.
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES - 19 VDC – 32 VDC lithium battery or external power supply.
Inverter required to operate on vehicle power source.
AUXILIARY EQUIPMENT - No information available

A15 Detector Name
DETALAC AUTOMATIC DETECTOR OF NERVE GAS AGENTS

Description:
Manufacturer
Giat Industries
Versailles Cedex, France

Technology
Flame Photometry

Type
- Military
- Detects vapors and aerosols

National Stock Number
No information available

Operational Parameters:
Agent Detection
Detects GB and VX

Alarm
No information available

Sensitivity
Manufacturer provided sensitivities are 0.05 mg/m^3 for GB

Selectivity/Interferants/False Alarms
Not highly selective
Interferants: Sulfur and Phosphorous containing compounds

Response Time
Less than 1 second

Start-Up Time
No information available

Logistical Parameters:
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES – *Hydrogen gas*

WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
33.02 x 22.09 x 39.11 cm

Weight
20 kg

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE **–** *Note this detector produces a flame and contains a hydrogen gas pack*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - *Battery*
AUXILIARY EQUIPMENT - No information available

<u>A16 Detector Name</u>
CONTINUOUS CHEMICAL AGENTS SENSOR (CHASE)

<u>Description:</u>
Manufacturer
Elbit-Ati Instruments
Attn: Jack Doherty
NMR Sales Manager
501 W. Lake Street, Suite 202
Elmhurst, IL 60126
(708) 993-0800 (TEL)
(708) 993-0825 (FAX)

Technology
CHASE operates on the principle of flame photometry. Air is pumped into the flame chamber where the flame combustion of all compounds present occurs. The luminous properties of the flame source are then analyzed by a dual system of optical filters focused on the emission of either phosphorous or sulfur. The entire spectrum emitted by the flame is analyzed and amplified, and the contributions of certain interferents are subtracted out electronically. The concentration of any agent present in the sampled air is indicated continuously on a gauge.

Type
- Detects vapors and aerosols

National Stock Number
No information available

<u>Operational Parameters:</u>
Agent Detection
Detects GB, VX, and HD

Alarm
No information available - *Yes*

Sensitivity
Detects G agents at 0.005 mg/m^3
Detects H agents at 0.05 mg/m^3

Selectivity/Interferants/False Alarms
Highly selective, uses relative emission intensities to distinguish interferents
Interferants: sulfur and phosphorous containing compounds

Response Time
Detection in 2 seconds

Start-Up Time
No information available

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES – Hydrogen gas
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - $50,000
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
40.64 x 15.24 x 33.02 cm

Weight
14 kg (27 kg with hydrogen bottle attached)

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note this detector produces a flame and contains a hydrogen gas bottle*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - No information available
AUXILIARY EQUIPMENT - No information available

<u>A17 Detector Name</u>
TYPE 1302 MULTIGAS MONITOR

<u>Description:</u>
Manufacturer
Bruel & Kjaer Instruments
Attn: Mr. Wayne Jalenak
Gas Mntring Appl. Engr.
185 Forest Street
Marlborough, MA 01752
(508) 481-7737 ext. 226 (TEL)
(508) 624-0503 (FAX)

Technology
Photoacoustic infrared spectrometer is capable of point detection of up to five gases using optical filters.

Type
- Commercial
- Detects vapors and aerosols

National Stock Number
NA

<u>Operational Parameters:</u>
Agent Detection
Detects GB, VX, and HD.

Alarm
Audio

Sensitivity
Detects GB, VX, and HD at 0.01-1.0 ppm, depending on temperature and humidity.

Selectivity/Interferants/False Alarms
Not highly selective
Automatically compensates for up to two interferents; high concentrations may be problematic.

Response Time
Less than 1 minutes

Start-Up Time
Less than 30 minutes

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*
AUTOMATIC OPERATION - Yes

Maintainability/Supportability
CALIBRATION - *Yes*
CONSUMABLES - *Batteries*
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - $24,435.00 to $28,835.00
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
No information available

Weight
13.5 kg

Transportability
Human Potable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note the IR source in this detector may be a glow bar, which could be hazardous in an explosive environment*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - 110 VAC-127 VAC and 200 VAC (50Hz – 400Hz) ± 10%
- Battery powered
AUXILIARY EQUIPMENT - No information available

A18 Detector Name

TYPE 1306 TOXIC-GAS MONITOR

Description:

Manufacturer

Bruel & Kjaer Instruments
Attn: Mr. Wayne jalenak
Gas Monitoring Appl. Engr.
185 Forest Street
Marlborough, MA 01752
(508) 481-7737 ext. 226 (TEL)
(508) 624-0503 (FAX)

Technology

Low cost photoacoustic infrared spectrometer is capable of monitoring for a single gas or group of gases depending on the optical filter selected and installed.

Type

- Commercial
- Detects vapors and aerosols

National Stock Number

NA

Operational Parameters:

Agent Detection

Detects GB, VX and HD.

Alarm

Audible

Sensitivity

Detects GB and HD at 0.01-1.0 ppm, depending on temperature and humidity.

Selectivity/Interferants/False Alarms

Not highly selective

Automatically compensates for up to two interferents; high concentrations may be problematic.

Response Time

~ 45-55 seconds

Start-Up Time

Less than 30 minutes

Logistical Parameters:

Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*
AUTOMATIC OPERATION - yes

Maintainability/Supportability
CALIBRATION - *Yes*
CONSUMABLES - *Batteries*
WASTE GENERATED - *None*
REPAIRS - Operates for extended periods without maintenance and requires only minimal surveillance.

Cost
INITIAL COST - 1306 monitor: $17,000
- Software/Misc. Hardware: $27,000
- Optical filters: $1,700

ANNUAL COST - No information available

Physical Parameters:

Size
10 x 20 x 40 cm

Weight
5.5 kg

Transportability
Human portable

Special Requirements:

Regulations
INTRINSICALLY SAFE – *Note the IR source in this detector could be a glow bar, which could be hazardous in an explosive environment*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - 12 VDC. power supply ZG0309 converts AC TO DC.
- 12 VDC vehicle battery used for brief monitoring.

AUXILIARY EQUIPMENT - No information available

A19 Detector Name
TOXIC GAS DETECTOR

DESCRIPTION
Manufacturer
Sensidyne, Inc.
16333 Bay Vista Drive
Clearwater, Fl 34620
800-451-9444 (TEL)
(813) 539-0550 (FAX)

Technology
Electrochemical

Type
- *Detects vapors and aerosols*
- *Commercial*

National Stock Number
NA

OPERATIONAL PARAMETERS
Agent Detection
Detects AC *(may not detect CWAs)*

Alarm
Visual and audio

Sensitivity
Detects AC at 0.5 ppm
(General 0.01-1 ppm)
Does not appear to have sensors for CWA

Selectivity/Interferants/False Alarms
Not highly selective
Electrochemical systems are known to false alarm in high concentrations of various smokes and engine exhausts.

Response Time
Detects AC in 60 Seconds

Start-Up Time
No information available

LOGISTICAL PARAMETERS

Ease of Operation

SKILL LEVEL - *Technical background*
TRAINING - *Formal training required*

Maintainability/Supportability

CALIBRATION - *None*
CONSUMABLES - *many electrochemical sensors are for one time use only*
WASTE GENERATED - *Possibly used sensors*
REPAIRS - No information available

Cost

INITIAL COST - $2,000.00
ANNUAL COST - No Information Available

PHYSICAL PARAMETERS

Size

19 x 8.4 x 4 cm

Weight

0.55 kg

Transportability

Human portable

SPECIAL REQUIREMENTS

Regulations

INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements

POWER SOURCES - No information available
AUXILIARY EQUIPMENT - No Information Available

<u>A20 Detector Name</u>
IMPROVED CHEMICAL AGENT DETECTOR (ICAD)

<u>Description:</u>
Manufacturer
Environment Technologies Group, Inc.
Chemical/Biological Warfare Marketing Manager
1400 Taylor Avenue
Baltimore, MD 21284-9840
(301) 321-5114/5200 (TEL)
(301) 321-5255 (FAX)

Technology
The ICAD electrochemical sensor module contains two miniature electrochemical sensors and a lithium battery. One sensor detects nerve, blood, and choking agents, the other detects blister agents. Chemical agent vapors diffuse through membranes on the sensors where they undergo electrochemical reactions. The electronics module continuously monitors the output from the sensor modules. When the threshold concentration of agent is reached, the unit sounds an audible alarm and an LED illuminates.

Type
- Military
- Detects vapor and aerosol

National Stock Number
6665-01-340-1693

<u>Operational Parameters:</u>
Agent Detection
Detects GB and HD.

Alarm
Audible and visual

Sensitivity
Detects GB at ≥ 5.0 mg/m^3
Detects HD at ≥ 10.0 mg/m^3
Detects GB, GA and GD at 0.2 to 5.0 mg/m^3
Detects HD and L at ≥ 50.0 mg/m^3

Selectivity/Interferants/False Alarms
Not highly selective
Electrochemical systems are known to false alarm to heavy concentrations of various smokes and engine exhausts.

Response Time
Detects HD in < 120 seconds
Detects HD and L in < 30seconds
Detects GA, GB and GD in < 120 seconds
Detects GB in < 30 seconds

Start-Up Time
No information available

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION - No information available
CONSUMABLES - Battery, sensor module
WASTE GENERATED – *None except used sensors*
REPAIRS - High sustainability. confidence level tester. Replacement of sensor module after four months of continuous operation. Change of battery. Shelf life of 5 years.

Cost
INITIAL COST - $1250.00 ($2800.00 in small quantities, $1400.00 in lots of 1000)*
ANNUAL COST – No information available

<u>Physical Parameters:</u>
Size
2.8 X 6.6 X 11 cm

Weight
215 g

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - A lithium battery internal to the electronics module
AUXILIARY EQUIPMENT - System Components

- electronics Module
- sensor module

- Support Equipment
  - the sensor module can be replaced by the operator, after four months of continuous service.

<u>A21 Detector Name</u>
NERVE AGENT IMMOBILIZED-ENZYME ALARM AND DETECTOR (NAIAD)

<u>Description:</u>
Manufacturer
Jasmin Simtec Limited
Attn: Dr. Simon Kerry
Sellers Wood Drive
Bulwell, Nottingham NG6 8UX
United Kingdom
44 115 9165165 (TEL)
44 115 9278614 (FAX)
37142 JASMIN G (TELEX)

Technology
The NAIAD is an automatic alarm system that monitors the atmosphere continuously and provides the user with an audible and/or visible signal indicating the presence of nerve agent vapor or aerosol. It uses potentiometric indirect biosensor technology and enzyme reaction.

Type
- Military
- Detects vapor and aerosol

National Stock Number
Base workshop test - 6665-99-966-3922
Battery - 6140-99-620-8057
- 6135-99-130-6823
Decontamination unit - 6665-99-225-4356
Detector unit - 6665-99-966-1252
Field test kit - 6665-99-966-3882
Refill kits - 6665-99-966-3883
Remote alarm unit - 6665-99-966-1253
Training kit - 6665-99-225-3949

<u>Operational Parameters:</u>
Agent Detection
Detects GB, GD, and VX.

Alarm
Audio and/or visual

Sensitivity
Nerve agents: 0.005 mg/m^3 to 0.05 mg/m^3 depending upon the agent.

Selectivity/Interferants/False Alarms
Classified –
Highly selective
Bio-sensor should be highly specific

Response Time
Classified

Start-Up Time
No information available

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION - *None*
CONSUMABLES – *Reagent solutions*
WASTE GENERATED – *Reagent solutions*
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
DETECTOR UNIT - 25.1 x 20.9 x 47.5 cm
REMOTE ALARM UNIT - 23.2 x 17.7 x 9.9 cm

Weight
DETECTOR UNIT - ~12.5 kg (with battery)
REMOTE ALARM UNIT - ~2.5 kg (with battery)

Transportability
Human portable or vehicle mountable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements

POWER SOURCES - Powered with an integral 3.3 AH NI/CD rechargeable battery and is operated on a 12-hour replenishment cycle.

- The remote alarm is powered by Hg batteries

AUXILIARY EQUIPMENT - System Components

- Battery
- Point sampling detection unit
- Remote alarm unit (reproduces the detector's audible and visual alarm signals at distances up to 500 meters)

- Support Equipment
  - -Base workshop test kit
  - -Battery charger
  - -Decontamination kit
  - -Field test kit
  - -Refill kit (enzyme pad holders, reagent modules)
  - -Test set
  - -Training kit
  - -Vehicle installation kit (scaled to detector)
  - -Vehicle modification kit (scaled to vehicle)

A22 Detector Name
SHIP INSTALLED CHEMICAL SYSTEM (SICS Mk. 7 NHA)

Description:

Manufacturer
Jasmin Simtec Limited
Sellers Wood Drive
Bulwell, Nottingham NG6 8UX
United Kingdom
44 115 9165165 (TEL)
44 115 9278614 (FAX)

Technology
The SICS is a detection system fitted to surface ships for detecting contamination of the air, by chemical attack both within the citadel and around the ship. The detector uses electro-chemical technology.

The sample is heated, passed through a filter into the detector cell and there it is mixed with a reagent solution. The reaction produces cyanide ions which cause a voltage to be developed between two electrodes. The change in electrical output is detected electrochemically, activating the alarm relay and stopping the pump motor.

Type
- Military
- Detects vapors and aerosols

National Stock Number
Detector unit - 6665-99-224-5930
Detector cell - 6665-99-224-6660
Air filter - 6665-99-224-6661
Through Bulkhead unit - 6665-99-224-5931
Replenishment kit - 6665-99-224-6564
On board test kit - 6665-99-527-9687
Test Set Dockyard - 6665-99-224-6617

Operational Parameters:

Agent Detection
No information available

Alarm
Relay (and visual alarm panel)

Sensitivity
Detects at 0.2 mg/m^3 to 0.4 mg/m^3

Selectivity/Interferants/False Alarms
Highly selective, dependent on filter, no information available
Low false alarm rate; details are classified.

Response Time
Classified

Start-Up Time
No information available

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING –*Formal training required*

Maintainability/Supportability
CALIBRATION - No information available
CONSUMABLES- Reagent solution filter pad
WASTE GENERATED – *Cyanide solution (RCRA regulated)*
REPAIRS – Modular design facilitaes maintenance and replacement of units; replacement of reagent solution and filter pad for each 24 hours of operation; on-board test kit and replenishment kit.

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
DETECTOR - 23 x 28 x 31 cm
BULKHEAD UNIT -30 x 21 x 51 cm

Weight
DETECTOR - 13.6 KG
BULKHEAD UNIT - 9.7 KG

Transportability
Vehicle portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Detection of nerve agent produces cyanide ions*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES – Ship power 115 VAC 60 HZ
AUXILIARY EQUIPMENT – System Components

- Bulkhead Unit (MK8NM)
- Detector Unit (MK7NHA)
- Network Control Unit
- Visual Alarm Panel

- Support Equipment
  - On-board Test Kit (MK28NTV)
  - Replenishment Kit
  - Test Set (MK27NTU) – Dockyard

A23 Detector Name
AUTOMATIC LIQUID AGENT DETECTOR (ALAD) SYSTEM

Description:
Manufacturer
Calspan, Operation of Veridian
Attn: Mr. Thomas McMahon
Director, Chemical/Biological Defense Group
P.O. Box 400
Buffalo, NY 14225
(716) 631-6905 (TEL)
(716) 631-4183 (FAX)

Technology
Electrochemistry based item that employs a single use sensor to detect small liquid droplets, frozen and thickened forms of blister and nerve agents via microprocessor based electronics.

Type
- Military
- Detects liquids (in droplet form), frozen and thickened nerve agent

National Stock Number
6665-01-314-2086

Operational Parameters:
Agent Detection
Detects GB, VX, and HD

Alarm
Audio and visual

Sensitivity
Detects VX in 200 micron liquid droplets.
Detects HD in 200 micron liquid droplets.
Detects GD in 200 micron liquid droplets

Selectivity/Interferants/False Alarms
Not highly selective
Electrochemical systems are known to false alarm to heavy concentrations of various smokes and engine exhausts.

Response Time
Detects HD - Battery powered @ +25°C in 10 seconds
- Battery powered @ +15°C in 50 seconds
- AC power @ -35°C in 1 second

Detects GD - Battery powered @ +25°C in 10 seconds
- Battery powered @ +15°C in 25 seconds
- AC power @ -35°C in 5 seconds

Detects VX - Battery powered @ +25°C in 20 seconds
- Battery powered @ +15°C in 35 seconds
- AC power @ -35°C in 15 seconds

Start-Up Time
No information available

Logistical Parameters:
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING - Formal training needed

Maintainability/Supportability
CALIBRATION - No information available
CONSUMABLES - Battery
- Sensors

WASTE GENERATED - No information available
REPAIRS - High Sustainability
- Bit for continuous read-out of detector status
- Operates unattended for 30 days
- Battery life of 30+ days
- MTBF≥5400 hours

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

Physical Parameters:
Size
31.2 x 24.4 x 13.4 cm

Weight
4.5 kg

Transportability
Human portable

Special Requirements:
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - some training is needed
MANDATORY SKILL LEVELS - *None*

Interface Requirements

POWER SOURCES - 12 VDC lithium battery (BA5588)
- 110/220 VAC 50-60 Hz
- Battery life – 30+ days

AUXILIARY EQUIPMENT - May be networked to remote alarms and communication centers

A24 Detector Name
M8 CHEMICAL AGENT DETECTOR PAPER, ABC-M8 VGH CHEMICAL AGENT DETECTOR PAPER AND M8 PAPER

Description:
Manufacturer
Anachemia canada inc.
ATTN: Ms. Magda Perfecto
500 Second Avenue
P.O. Box 147
Lacine (Montreal), Quebec H8S 4A7
Canada
(514) 489-5711 (TEL)
(514) 485-9825 (FAX)
055-66129 (TELEX)

Technology

Reaction chemistry - There are three sensitive dyes suspended in the paper matrix. The paper is blotted on a suspected liquid agent and observed for a color change. There is a color chart inside the front cover of the booklet for comparison. The chemical reaction between the M8 paper and chemical agent creates a pH dependent color change on the M8 paper. V-type nerve agents turn the M8 paper dark green, G-type nerve agents turn it yellow, and blister agents (H) turn it red.

Type
- Military
- Detects liquids

National Stock Number
6665-00-050-8529

Operational Parameters:
Agent Detection
Detects HD, GB, and VX.

Alarm
None

Sensitivity
Responds to droplets of 0.02 ml or larger

Selectivity/Interferants/False Alarms
Not highly selective
M8 paper responds to some common battlefield interferents. Among them are, certain cleaning solvents (ammonia), DS2, “break free” (a weapons cleaner and lubricant), high

temperatures, and some petroleum products. M8/M9 papers should not be used as a sole verification of the presence of an agent.

Response Time
Color change occurs within 30 seconds.

Start-Up *Time*
None

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL - No technical background
TRAINING - No formal training

Maintainability/Supportability
CALIBRATION/REPAIR - *None*
CONSUMABLES - Tickets are consumable
WASTE GENERATED - Used ticket
REPAIRS - *None*

Cost
INITIAL COST - $0.78
ANNUAL COST – *Less than $10.00*

<u>Physical Parameters:</u>
Size
10 X 6.5 cm

Weight
0.02 kg

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - *None*
AUXILIARY EQUIPMENT - *None*

A25 Detector Name

M9 CHEMICAL AGENT DETECTOR PAPER, M9 PAPER

Description:

Manufacturer

Truetech, Inc.
680 Elton street
Riverhead, NY 11901
(516) 727-8600 (TEL)
(516) 727-7592 (FAX)

Technology

M9 paper contains a suspension of an agent sensitive dye in a paper matrix. It detects small droplets of liquid agent. The paper is gray/green in color and turns pink, reddish-brown, or red-purple in contact with agent droplets or liquid. It does not distinguish between mustard and nerve agents. There are three sensitive indicator dyes suspended in the paper matrix. The paper is blotted on a suspected liquid agent and observed for a color change.

Type

- Military
- Detects liquids

National Stock Number

6665-01-049-8982

Operational Parameters:

Agent Detection

Detects GB,VX, HD

Sensitivity

Responds to 100 microliter or larger droplets

Selectivity/Interferants/False Alarms

Not highly selective

M9 paper responds to some common battlefield interferents. Among them are petroleum products, brake fluid, aircraft cleaning compound, DS2, insect repellant, sand color camouflage stick, FS smoke, defoliant, ethylene glycol, and scuffs of dirt or mud. The M9 paper will not respond to chemical agents when wet and will give false positive indications when abraded against a rough surface. Heat may cause it to turn red and cause false positive readings.

Response Time

Detects in 20 seconds or less.

Start-Up Time
Start up time is immediate.

<u>**Logistical Parameters:**</u>
Ease of Operation
SKILL LEVEL – No technical background
TRAINING – No formal training

Maintainability/Supportability
CALIBRATION – *None*
CONSUMABLES - Paper is consumed
WASTE GENERATED -Used paper

Cost (initial cost, maintenance cost, supportability cost, training cost)
INITIAL COST - $4.27
ANNUAL COST – *Less than $20.00*

<u>**Physical Parameters:**</u>
Size
Dispenser box - 6.4 X 8.9 X 8.3 cm
Detector paper - 9.1 X 5.1 cm

Weight
Dispenser box - 0.1984 kg

Transportability
Human portable

<u>**Special Requirements:**</u>
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCE - *None*
AUXILIARY EQUIPMENT - *None*

<u>A26 Detector Name</u>
PAPER, CHEMICAL AGENT LIQUID DETECTORS, 3-WAY

<u>Description:</u>
Manufacturer
Anachemia Canada Inc.
ATTN: Ms. Magda Perfecto
500 Second Avenue
P.O. Box 147
Lacine (Montreal), Quebec H8S 4A7
(514) 489-5711 (TEL)
(514) 485-9825 (FAX)
055-66129 (TELEX)

Technology
Crystals of dye are suspended in the detection paper matrix. On contact with a liquid agent, which acts as a solvent, the dye crystals dissolve and a color change is observed.

Type
- Military
- Detects liquid, *and aerosols*

National Stock Number
6665-21-858-8464

<u>Operational Parameters:</u>
Agent Detection
Detects GB and VX

Alarm
None

Sensitivity
.02 ml droplet

Selectivity/Interferants/False Alarms
Not highly selective
Color change may occur with some solvents and solvent/base mixtures.

Response Time
Response time is immediate

Start-Up Time
Immediate

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL - No technical background
TRAINING - No formal training

Maintainability/Supportability
CALIBRATION - None
CONSUMABLES - Yes, sheet of paper
WASTE GENERATED – Yes, used paper, may contain CWA
REPAIRS - NA

Cost
INITIAL COST - $2.97
ANNUAL COST – *Less than $10.00*

<u>Physical Parameters:</u>
Size
10 x 6.5 x 0.5 cm

Weight
25 g

Transportability
Easily transportable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING – None
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES - None
AUXILIARY EQUIPMENT - None

A27 Detector Name
C2 CHEMICAL AGENT DETECTOR KIT

Description:
Manufacturer
Anachemia Canada Inc.
ATTN: Ms. Magda Perfecto
500 Second Avenue
P.O. Box 147
Lacine (Montreal), Quebec H8S 4A7
(514) 489-5711 (TEL)
(514) 485-9825 (FAX)
055-66129 (TELEX)

Technology
The C2 kit is a multi-component kit which uses colorimeteric chemical reaction technology for detecting nerve, blister, blood and choking agents in vapor form, and nerve and blister agents in liquid form. The presence or absence of a chemical agent is indicated by a color change reaction.

Type
- Military
- Detects liquids, vapors, *and aerosols*

National Stock Number
C2 Detection Kit - 6665-21-870-6740 (NSN)
NAVD - 6665-21-846-4563 (NSN)
3-Way Detector Paper - 6665-21-858-8494 (NSN)

Operational Parameters:
Agent Detection
Detects GB, VX, and *HD*

Alarm
None

Sensitivity
The 3-way detector paper will detect G, H, and V agents with a minimum drop size of 0.075 mm.

Selectivity/Interferants/False Alarms
Not highly selective
3-way detector paper may change color with some insect repellants, insecticides, defoliants, and plant growth regulators. Vapor detectors are very specific and not expected to give false responses if used appropriately.

Response Time
Varies from immediate, for liquid agent detection, to several minutes, for vapor agent detection.

Start-Up Time
Immediate

Logistical Parameters:

Ease of Operation
SKILL LEVEL – Technical bgackground
TRAINING - Formal training

Maintainability/Supportability
CALIBRATION - None
CONSUMABLES - Tickets and glass tubes
WASTE GENERATED – Used paper, glass tubes and reagents may have CWA
REPAIRS - None

Cost
INITIAL COST - $500.00
ANNUAL COST – *Purchase of new paper and reagents, if used up*

Physical Parameters:

Size
23 x 9 x 14 cm

Weight
1.4 kg

Transportability
Human portable

Special Requirements:

Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES – None required
AUXILIARY EQUIPMENT - For unknown vapor samples collected in the white-band detector tubes, appropriate gas analyzing equipment is required for agent identification. The rest of the C2 kit is stand-alone.

A28 Detector Name
M18A2 CHEMICAL AGENT DETECTOR KIT

Description:
Manufacturer
Truetech, Inc.
680 Elton Street
Riverhead, NY 11901
(516) 727-8600 (TEL)
(516) 727-7592 (FAX)

Technology
The M18A2 kit uses a number of different chemical reactions, primarily enzymatic-substrate based wet chemistry for nerve agents, and silica gel adsorbent color changes for other agents. Upon addition of reagent, the tube will turn to a purple color in the presence of HD vapor and yellow-orange or blue-green in the presence of GB vapor (depending upon the reagent used).

Type
- Military
- Detects vapors and aerosols

National Stock Number
- M18A2 Kit - 6665-00-903-4767
- M30A1 Refill Kit - 6665-00-909-3647
- Aspirator Bulb - 6640-00-630-7695

Operational Parameters

Agent Detection
HD, GB, and VX

Alarm
None

Sensitivity
Detects HD at 0.5 mg/m^3.
Detects GB at 1.0 mg/m^3 (tube).
Detects GB and VX at 0.1 mg/m^3 (ticket).
Sensitivity decreases with lowering temperature.

Selectivity/Interferants/False Alarms
Not highly selective
Responds to some battlefield interferent materials including smoke and decontaminants

Response Time
- Detects HD in 3 minutes.
- Detects GB in 2 minutes.
- Detects GB and VX in 4 minutes.

Start-Up Time
Immediate

Logistical Parameters:
Ease of Operation
SKILL LEVEL - Technical background
TRAINING - Formal training

Maintainability/Supportability
CALIBRATION -NA
CONSUMABLES - M30A1 refill kit contains one buffer solution (white marked bottle), one substrate solution (red-marked dispenser), one belt of 40 tickets, one book of M8 paper and an instruction card
WASTE GENERATED – Tickets and reagent solutions

Cost
INITIAL COST - $294.00
ANNUAL COST – *Depends on shelf life of reagents*

Physical Parameters:
Size
20.3 X 7.62 X 15.24 cm

Weight
1.13 kg

Transportability
Human portable

Special Requirements:
Regulations
INTRINSICALLY SAFE – *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCE - None
AUXILIARY EQUIPMENT - System Components
- carrier
- instruction cards

  - detector tubes (5 clips of 25 each)(blue-band, red-band, green-band, and yellow-band)
  - sampling tubes (white-band)
  - M8 chemical agent detector paper
  - detector tickets
  - plastic squeeze bottles (color coded) with matching color caps
  - aspirator bulb assembly
  - glass vial (green marked containing 14 tablets)
  - packets (straws containing powder reagent)
  - plastic container (for glass vials and packets)
  - dispenser (red marked)
  - report cards (in envelopes)
- Support Equipment
  - The M30A1 refill kit contains one filled buffer solution (white marked bottle), one substrate solution(red marked bottle), one belt of 40 tickets, one book of M8 paper and an instruction card

<u>A29 Detector Name</u>
M256 KIT, M256A1 KIT

<u>Description:</u>
Manufacturer
Anachemia Canada Inc.
Attn: Ms. Magda Perfecto
500 Second Avenue
P.O. Box 147
Lacine (Montreal), Quebec H8S 4A7
(514) 489-5711 (TEL)
(514) 485-9825 (FAX)
055-66129 (TELEX)

Technology
Wet chemistry enzymatic substrate based reactions. In the presence of HD, a distinctive purple-blue color change is obtained after proceeding according to instructions on use of the sampler. In the absence of GB/VX, a distinctive blue color change is obtained.

Type
- Military
- Detects vapors and aerosols

National Stock Number
6665-01-133-4964

<u>Operational Parameters:</u>
Agent Detection
Detects HD, GB, VX

Alarm
NA

Sensitivity
- Detects HD at 2.0 mg/m^3.
- Detects GB at 0.005 mg/m^3.
- Detects VX at 0.02 mg/m^3.

Selectivity/Interferants/False Alarms
Some smokes, high temperatures, DS2, and petroleum products may cause false readings.

Response Time
- The response time of the sampler increases as the temperature decreases.
- The entire operating time for the kit is fifteen minutes.
- The actual exposure time of the spots to the air is ten minutes.

Start-Up Time
Immediate

Logistical Parameters:
Ease of Operation
SKILL LEVEL - Non-Technical Background
TRAINING - Non-Formal Training

Maintainability/Supportability
CALIBRATION - NA
CONSUMABLES - KIT.
WASTE GENERATED - Each sampler-detector contains 2.6 mg of mercuric cyanide. The expended m256 kit is a rcra listed waste.
REPAIRS - none – one use kit

Cost
INITIAL COST - $39.93
ANNUAL COST - not available

Physical Parameters:
Size
17.8 x 7.6 x 12.7 cm

Weight
0.5 kg

Transportability
The M26 kit can not be used effectively on the move.
The M256A1 is portable

Special Requirements:
Regulations
REQUIRED LICENSES - NA

Interface Requirements
POWER SOURCE - none
AUXILIARY EQUIPMENT - system components
- Each kit consists of 12 disposable plastic sampler-detectors, one booklet of M8 paper, and a set of instruction cards attached by a lanyard to a plastic carrying case. The case is made from molded, high impact plastic and has a nylon carrying strap and a nylon belt attachment. Each sampler/detector contains a square impregnated spot for blister agents, acircular test spot for blood agents, a star test spot for nerve agents, and a lewisite detecting tablet and rubbing tab. The test spots are made of standard

laboratory filter paper. There are eight glass ampoules, six containing reagents for testing and two in an attached chemical heater.

- Support Equipment
    - M8 paper can be ordered for resupply as needed

A30 Detector Name
M272 WATER TESTING KIT
M272 CHEMICAL AGENTS WATER TESTING KIT
M272 KIT

Description:
Manufacturer (name and location)

Truetech, Inc.
680 Elton Street
Rivergead, NY 11901
(516) 727-8600 (TEL)
(516) 727- 7592 (FAX)

Technology (description of detection technology and basic operation)
The M272 kit employs wet chemistry reactions and enzyme-substrate reaction. To test for nerve agent, the white patch on a test ticket is wetted by a water sample. It is placed in a clip for an indicated time and then pressed against the pink patch opposite on the ticket. If the white patch turns blue, there are no nerve agents present. Tests for other agents involve filling the test container with a water sample. A reagent is added and after breaking off the ends of either the blue or red banded glass tubes, the tubes are inserted in the rubber connector. The color of the beads in the glass tubes are compared to the appropriate tset color chart to determine agent presence.

Type (military, commercial and liquid, vapor, aerosol)
In use by most nato countries.
Adopted into the U.S. Army inventory in 1983. Over 61,000 M272 kits have been produced.

DETECTS AGENTS IN WATER SAMPLES

National Stock Number
6665-01-134-0885

Operational Parameters:
Agent Detection (ability to detect GB, VX, and HD)
Detects HD, G and V agents.

Alarm
NA

Sensitivity
- Detects HD and L at 2.0 mg/l.
- Detects G and V at 0.02 mg/l.

Selectivity/Interferants/False Alarms
The M272 may respond to some battlefield interferents.

Response Time
- Detects HD and L in 7 minutes.
- Detects G and V in 7 minutes.

Start-Up Time
None

Logistical Parameters:
Ease of Operation (skill level, training)
SKILL LEVEL - no information available
TRAINING - some training is required

Maintainability/Supportability (calibration, consumables, waste generated, repairs)
CALIBRATION - none
CONSUMABLES - no information available
WASTE GENERATED - no information available
REPAIRS - none – kit is disposable

Cost (initial cost, maintenance cost, supportability cost, training cost)
INITIAL COST - $178.00
MAINTENANCE COST - no information available
SUPPORTABILITY COST - no information available
TRAINING COST - no information available

Physical Parameters:
Size (Length x Width x Height)
25.1 X 15.9 X 7 cm

Weight
1.1 kg

Transportability
Human Portable

Special Requirements:
Regulations (required licenses, mandatory training/skill levels)
REQUIRED LICENSES - no information available
MANDATORY TRAINING - some training is required
MANDATORY SKILL LEVELS - no information available

Interface Requirements (power sources, auxiliary equipment)
POWER SOURCES - none; manually operated
AUXILIARY EQUIPMENT - System Components

- chemical agent detector tubes (banded with blue or red)
- chemical agent test reagents
- clip
- heat resistant plastic test container (with a rubber stopper and a connector)
- instruction card
- nerve agent test tickets
- rubber connectors (extras)
- thermometer
- training simulants
- tube holder (fits in the lid)
- waterproof matches and striking strip

- Support Equipment
  - none required

A31 Detector Name
NERVE AGENT VAPOR DETECTOR (NAVD)

Description:
Manufacturer (name and location)
Anachemia Canada Inc.
Attn: Ms. Magda Perfecto
255 Norman, Ville St.
(514) 489-5711 (TEL)
(514) 485-9825 (FAX)
055-66129 (TELEX)

Technology (description of detection technology and basic operation)
Navd is an enzyme based detector used to determine the presence of nerve agent vapors.

Type (military, commercial and liquid, vapor, aerosol)
Deployed to several nato countries.
Detects vapors

National Stock Number
NSN 6665-21-846-4563

Operational Parameters:
Agent Detection (ability to detect GB, VX, and HD)
Detects GB and VX.

Alarms
No information available

Sensitivity
- Detects GB at 0.004 mg/m^3.
- Detects VX at 0.007 mg/m^3.

Selectivity/Interferants/False Alarms
Strong acid vapors may give positive response. Strong alkaline vapors may give negative response.

Response Time
Immediate

Start-Up Time
Immediate

Logistical Parameters:
Ease of Operation (skill level, training)
SKILL LEVEL - no technical background

TRAINING - no formal training

Maintainability/Supportability (calibration, consumables, waste generated, repairs)
CALIBRATION - n/a
CONSUMABLES - enzyme impregnated test paper
WASTE GENERATED - yes, used tickets
REPAIRS - n/a

Cost (initial cost, maintenance cost, supportability cost, training cost)
INITIAL COST - 2.97
MAINTENANCE COST - n/a
SUPPORTABILITY COST - n/a
TRAINING COST - n/a

<u>Physical Parameters:</u>
Size (Length x Width x Height)
5.5 cm x 2.5 cm x 0.2 cm

Weight
25 gm

Transportability
Human Portable

<u>Special Requirements:</u>
Regulations (required licenses, mandatory training/skill levels)
REQUIRED LICENSES - n/a
MANDATORY TRAINING - n/a
MANDATORY SKILL LEVELS - n/a

Interface Requirements (power sources, auxiliary equipment)
POWER SOURCES - n/a
AUXILIARY EQUIPMENT - n/a

A32 Detector Name
No.1 MARK 1 DETECTOR KIT CHEMICAL AGENT RESIDUAL VAPOR (RVD)

Description:
Manufacturer
Richmond Packaging (UK) Limited
New Road
Winsford, Chesire CW7 2NY
United Kingdom
441 606 557422 (TEL)
441 606 861063 (FAX)

Technology
Wet chemistry using reagents that cause a color change to indicate the presence of agent vapors.

Type
- Military
- Detects vapors and aerosol VX

National Stock Number
6665-99-961-6082

Operational Parameters:
Agent Detection
Detects HD, GB and VX
ALARM *None*

Sensitivity
Detects GB and GD at 0.02 mg/m^3
Detects VX at 0.04 mg/m^3
Detects VX (aerosols) at 4 microns
Detects HD at 0.05 mg/m^3

Selectivity/Interferants/False Alarms
Not highly selective
False positives are caused when Cl_2 is at concentrations of greater than 10 to 20 ppm and SO_2 is at concentrations of greater than 3 ppm or if there is very dense and acrid wood smoke. Field trials performed in the presence of common battlefield contaminants such as efflux from weapons propellants, vehicle exhaust and screening smokes, have not revealed any practical interference problems.

Response Time
The response time is temperature and agent concentration dependant.

Start-Up Time
3 minutes

Logistical Parameters:
Ease of Operation
SKILL LEVEL - Technical background
TRAINING - Formal training usually required

Maintainability/Supportability
CALIBRATION - No calibration required
CONSUMABLES - Spare tickets and chemicals are available
WASTE GENERATED - Used tickets and empty chemical bottles
REPAIRS - None

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

Physical Parameters:
Size
15 x 13 x 5 cm

Weight
0.35 kg

Transportability
Human portable

Special Requirements:
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - UK Government Export License
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS – None

Interface Requirements
POWER SOURCES - None
AUXILIARY EQUIPMENT - System Components
- The kit consists of a water repellent canvas wallet containing plastic instruction cards, detector tickets, reagents and an atmospheric sampling device (air pump) fitted with an adapter to receive the detector ticket.

- Support Equipment
  - Nerve agents can be simulated for training using a tactical training aid

<u>A33 Detector Name</u>
DRAGER-TUBE GAS DETECTION SYSTEM

<u>Description:</u>
Manufacturer
National Drager Inc.
Attn: Mr. Edward G. Ligus
101 Technology Drive
P.O. Box 120
Pittsburgh, PA 15230-0120
(800) 922-5518 (TEL)
(800) 922-5519 (FAX)
510-600-3063 (TELEX)

Technology
Color change chemistry

Type
- Commercial
- Military
- Detects vapors and aerosols

National Stock Number
No information available

<u>Operational Parameters:</u>
Agent Detection
Vapor agents (Thioether detects HD; Phosphoric acid esters detects GB and VX)

Alarm
None

Sensitivity
Detects at 0.02-30 ppm.
Detects at 1-15 mg/m^3

Selectivity/Interferants/False Alarms
Not highly selective
Functionally dependent

Response Time
Less than 5 minutes

Start-Up Time
Less than 1 minute

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *No training required*
AUTOMATIC OPERATION - no

Maintainability/Supportability
CALIBRATION - *None*
CONSUMABLES - Specific Drager tube
WASTE GENERATED – *Reagent solutions, may contain CWA*
REPAIRS - Replacement of respective Drager tube. Shelf life of two years

Cost
INITIAL COST - *$140*
ANNUAL COST – No information available (shelf life of 2 years)

<u>Physical Parameters:</u>
Size
< 0.03 m^3

Weight
< 13.5 kg

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - None
AUXILIARY EQUIPMENT - None
ELECTRONIC - No

A34 Detector Name
SAW MINICAD MKII

Description:
Manufacturer
Microsensor Systems, Inc.
Attn: Dr. Hank Wohltsen
62 Corporate Ct.
Bowling Green, KY 42103
(502) 745-0099 (TEL)
(502) 745-0095 (FAX)

Technology
The SAW MINICAD MKII uses a pair of solid-state Surface Acoustic Wave (SAW) microsensors which are extremely sensitive to small changes in the mass of surface coatings that act as "sponges" for chemical warfare agent vapors. Vapor samples are collected, concentrated, and passed over the SAW microsensor array by means of a small diaphragm pump and a thermally desorbed concentrator. An onboard microcomputer analyzes the saw sensor responses and determines whether or not a hazardous condition exists.

Type
- Commercial
- Developmental
- Detects vapors and aerosols

National Stock Number
NA

Operational Parameters:
Agent Detection
Detects GB, VX, AND HD.

Alarm
Audible and visible

Sensitivity
Detects GB at 1.00 mg/m^3
Detects VX at 0.1 mg/m^3
Detects HD at 0.6 mg/m^3

Selectivity/Interferants/False Alarms
Highly selective, dependent on the concentrator selectivity
Coatings will influence specificity
Prone to interferents - *unspecified*

Response Time
Detects in 60 second.

Start-Up Time
Start Up In Two Minutes

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*
AUTOMATIC OPERATION

Maintainability/Supportability
CALIBRATION - No information available
CONSUMABLES - *Batteries*
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - $5,495.00
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
19 X 10 X 5.4 cm (11 X 13 X 3.2 cm)

Weight
0.425 kg (0.5 kg)

Transportability
The Minicad MKII is supplied with a soft, padded carrying case that permits the instrument to be worn on a belt or suspended from an adjustable shoulder strap (included).
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - 4 Lithium Cells, Type DL 123A
- An external 6.3V, 3.4 Amp-hr, rechargeable, fully sealed, lead-acid, gel-cell is supplied with every Minicad

- A battery charger for the external rechargeable battery is supplied with every Minicad.

AUXILIARY EQUIPMENT - A small vapor diffusion tube is supplied with the Minicad to permit vapor testing of the instrument in the field.

- The Minicad MKII contains an i/o port to permit RS232 serial communication with external devices (e.g., a personal computer).
- Audio and visual alarms

A35 Detector Name
CAA/2

Description:
Manufacturer
Microsensor System Inc.
Attn: Dr. Hank Wohltsen
62 Corporate Ct.
Bowling Green, KY 42103
(502) 745-0099 (TEL)
(502) 745-0095 (FAX)

Technology
Acoustic Wave Sensor

Type
- Commercial
- Developmental
- Detect vapors and aerosols

National Stock Number
NA

Operational Parameters:
Agent Detection
Detects HD, GB, and VX.

Alarm
Audio and Visual

Sensitivity
GB 1 mg/m^3
VX 0.1 mg/m^3
HD 0.6 mg/m^3

Selectivity/Interferants/False Alarms
Not highly selective
Coatings will influence specificity; prone to interferents.

Response Time
60 seconds

Start-Up Time
2 minutes

Logistical Parameters:

Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION - No information available
CONSUMABLES - *Batteries*
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - *$5,500*
ANNUAL COST - No information available

Physical Parameters:
Size
Handheld

Weight
< 13.5 kg

Transportability
Human portable

Special Requirements:
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - Battery powered
AUXILIARY EQUIPMENT - No information available

<u>A36 Detector Name</u>
PHOTOVAC MICROTIP HANDHELD AIR MONITOR / PHOTOIONIZATION DETECTOR

<u>Description:</u>
Manufacturer
Photovac International Inc.
Attn: Steve Kane
25-B Jefryn Blvd.
West Deer Park, NY 11729
(516) 254-4199 (TEL)
(516) 254-4284 (FAX)

Technology
Photo Ionization

Type
- Commercial
- Detects *vapors*

National Stock Number
No information available

<u>Operational Parameters:</u>
Agent Detection
No information available – *detects GB, VX, and HD*

Alarm
Audio and visual

Sensitivity
No information available -
Detects GB at 0.01 mg/m^3
Detects VX at 0.015 mg/m^3
Detects HD at 0.4 mg/m^3

Selectivity/Interferants/False Alarms
No information available –
Not highly selective
Photo ionization detectors are not very specific any species with an ionization potential close to that of the agents in question may cause a false alarm

Response Time
No information available -
- *Detects GB in 2 seconds*
- *Detects VX in 2 seconds*

- *Detects HD in 2 seconds*

Start-Up Time
- No information available –
- *If temperature is > 0°C, start up time is 2 minutes*
- *If temperature is < 0°C, start up time is 10 minutes maximum*

Logistical Parameters:

Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION - No information available
CONSUMABLES – *periodic (1 to 2 years) lamp replacement and batteries*
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - no information available
ANNUAL COST - no information available

Physical Parameters:

Size
No information available

Weight
< 14 kg

Transportability
Human portable

Special Requirements:

Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES – Battery powered
AUXILIARY EQUIPMENT – No information available

<u>A37 Detector Name</u>
IS-101

<u>Description:</u>
Manufacturer (name and location)
HNU Systems, Inc.
160 Charlemont Street
Newton, MA 02161-9987
TEL: (617) 964-6690
FAX: (617) 558-0056

Technology
Photoionization detection

Type
- Detects vapors

National Stock Number
NA

<u>Operational Parameters:</u>
Agent Detection
Detects GB, VX, and HD

Sensitivity
Low PPM

Selectivity/Interferants/False Alarms
Not highly selective
Specificity depends on availability of lamps to produce specific output energy desired.

Response Time
< 3 seconds to 90% of full scale

Start-Up Time
None

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING - Formal training

Maintainability/Supportability
CALIBRATION - Calibrated daily with gas available from HNU
CONSUMABLES - Lamps $500, every 1 to 2 years
WASTE GENERATED - No waste

REPAIRS - $295 plus parts

Cost
INITIAL COST - $4,195
ANNUAL COST - *$1,500*

Physical Parameters:
Size
Probe 6.3 x 34.3 cm
Readout 8.4 x 13.2 x 16.5 cm

Weight
6 kg

Transportability
Human portable

Special Requirements:
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS – None

Interface Requirements
POWER SOURCES - Operates on rechargeable batteries, recharger uses 120 VAC.
AUXILIARY EQUIPMENT - None

A38 Detector Name
MINIRAE Plus

Description:
Manufacturer
Rae Systems
680 West Maude Avenue #1
Sunnyvale, CA 94086
(408) 481-4999 (TEL)
(408) 481-4998 (FAX)

Technology
Photoionization Detection

Type
- Commercial
- Detects vapor

National Stock Number
NA

Operational Parameters:
Agent Detection
Detects HD, GB, and VX.

Alarm
Audio and visual

Sensitivity
GB approximately 1.0 ppm
VX approximately 0.3 ppm
HD approximately 0.1 ppm

Selectivity/Interferants/False Alarms
Not highly selective
Specificity depends on availability of lamps to produce specific output energy desired.
Non specific

Response Time
Less than 3 seconds

Start-Up Time
1 minute

Logistical Parameters:

Ease of Operation
SKILL LEVEL –Technical background
TRAINING – No formal training

Maintainability/Supportability
CALIBRATION – User – test before use / calibrate as needed.
CONSUMABLES – Calibrating gas and dust filters
WASTE GENERATED - None
REPAIRS - As needed

Cost
INITIAL COST - $4,000/unit
ANNUAL COST – Approximately $300/year

Physical Parameters:

Size
18 x 7 x 4.5 cm

Weight
0.51 kg

Transportability
Human portable

Special Requirements:

Regulations
INTRINSICALLY SAFE – *Yes, note calibration gas is probably compressed*
REQUIRED LICENSES - None
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES - Two 6 VDC rechargeable batteries
AUXILIARY EQUIPMENT – 110 VAC adapter/charger, remote probe

A39 Detector Name
MINIATURE CHEMICAL AGENT MONITOR (MINICAM)

Description:
Manufacturer
CMS Research Corporation
Attn: Mr. Daniel R. Coleman
200 Chase Park South, Suite 100
Birmingham, AL 35244
(205) 733-6900 (TEL)
(205) 733-6919 (FAX)

Technology
The MINICAM is an automatic air monitoring system that collects compounds on a solid sorbent trap, thermally desorbs them into a capillary gas-chromatography unit column for separation, and detects the compounds with a flame-photometric detector.

Type
- Commercial
- Military
- Detects vapors and aerosols

National Stock Number
No information available

Operational Parameters:
Agent Detection
Detects GB, VX, and HD.

Alarm
Audio, and visual

Sensitivity
Detects GB at 0.00001 mg/m^3.
Detects VX at 0.000001 mg/m^3.
Detects HD at 0.0003 mg/m^3

Selectivity/Interferants/False Alarms
Highly selective
Flame photometric systems are known to false alarm to sulfur and phosphorous compounds. However, gas chromatograph minimizes false alarms from interferents.

Response Time
Detects GB in less than 5 minutes.
Detects VX in less than 15 minutes.
Detects HD in less than 5 minutes.

Overall 3 – 10 minutes.

Start-up time
No information available

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical specialist*
TRAINING – *Formal training required*
AUTOMATIC OPERATION – *Yes*

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES – *Gas for GC and detector*
WASTE GENERATED - *None*
REPAIRS - *Required*

Cost
INITIAL COST- $24,873.00
Annual Cost – No information available

<u>Physical Parameters:</u>
Size
25.4 x 30.5 x 21.5 cm

Weight
8.6 kg

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note this detector produces a flame and contains a hydrogen gas pack*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - Not battery powered, *house current, 110 VAC*
AUXILIARY EQUIPMENT - No information available

<u>A40 Detector Name</u>
SCENTOGRAPH PLUS II WITH AID/RCD DETECTOR

<u>Description:</u>
Manufacturer
Sentex Systems Inc.
Attn: Dr. Amos Linenberg
553 Broad Ave.
Ridgefield, NJ 07657
(201) 945-3694 (TEL)
(201) 941-6061 (FAX)

Technology
Gas chromatography with argon ionization/electron capture

Type
- Commercial
- Detects liquids, vapors, and aerosols

National Stock Number
None

<u>Operational Parameters:</u>
Agent Detection
Detects HD, GB, and VX.

Alarm
Audio and visual

Sensitivity
HD has been tested at 10 ppb
GB has been tested at 3.5 ppb

Selectivity/Interferants/False Alarms
Highly selective
Selectivity high, molecules with an identical retention time as the agents can act as interferants

Response Time
Less than 2 minutes

Start-Up Time
30 minutes to equilibrate from a cold start.

<u>Logistical Parameters:</u>
Ease of Operation

SKILL LEVEL - Technical specialist
TRAINING – Formal training

Maintainability/Supportability
CALIBRATION - Recommended to calibrate every 12 hours
CONSUMABLES - Argon gas (ultra high purity), syringes, tedlar bags, and water vials
WASTE GENERATED - This is non-destructive so the exhaust stream may contain agent

Cost
INITIAL COST - $24,835
- Free training at factory ($950 + expenses for off sight training)

ANNUAL COST - $1,000/YEAR
- Technical support for 8% of purchase price/year

<u>Physical Parameters:</u>
Size
15.24 x 52.07 x 50.8 cm

Weight
14 kg

Transportability
Human Portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note the GC uses a bottle of high pressure argon gas*
REQUIRED LICENSES - None
MANDATORY TRAINING - Yes (from Sentex)
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - Battery powered
AUXILIARY EQUIPMENT - Battery charger supplied

A41 Detector Name
MINITUBE AIR SAMPLING SYSTEM (MASS)

Description:
Manufacturer
Canadian Centre For Advanced Instrumentaion (Saskatchewan Research Council)
Attn: Craig Murray
15 Innovation Blvd.
Saskatoon, Saskatchewan
Canada S7N 2X8
(306) 933-5482 (TEL)
(306) 933-7446 (FAX)
Email: MURC@SRC4330.SRC.SK.CA

Technology
Miniaturized solid-sorbent air sampling tubes (50) contained in a carousel housing which mates with an automated air sampler. The tube carousel also serves as the storage and transport container for the sample tubes. The tubes may be directly analyzed by thermal desorption gas chromatography without physical removal from the housing.

Type
- Military/commercial
- Detects vapors and aerosols, *Note that this is a sampling device and requires a GC for analysis of the sample, the GC can be attached to the carousel for detection at the point of sampling.*

National Stock Number
No information available

Operational Parameters:
Agent Detection
Detects GB, VX, and HD

Alarm
None

Sensitivity
Typical gas chromatographic sensitivity is in the nanogram (10^{-9}) to picogram (10^{-12}) range.

Selectivity/Interferants/False Alarms
Highly selective, if GC used is selective
High, depends on complexity of air sample collected and selectivity of analytical equipment and analytical procedure.

Response Time
Greater than 1 hour

Start-Up Time
No information available

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Some training required*

Maintainability/Supportability
CALIBRATION – *Required for the GC analyzer*
CONSUMABLES – *GC supplies*
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
23 x 12 x 33 cm

Weight
11.7 kg

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *The GC probably uses high pressure bottled gas*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - Air samplers may be powered from small battery pack or use AC power (115 V AC/230 V AC) depending on application
AUXILIARY EQUIPMENT – No information available

<u>A42 Detector Name</u>
PORTABLE ODOR MONITOR

<u>Description:</u>
Manufacturer
Sensidyne, Inc.
16333 Bay Vista Drive
Clearwater, FL 34620
800-451-9444
FAX: (813) 539-0550

Technology
Thermal and Electrical Conductivity

Type
- Detects changes in vapor concentration

National Stock Number
No information available

<u>Operational Parameters:</u>
Agent Detection
Does not look like it presently comes with CWA detection heads

ALARMS
Audio and visual

Sensitivity
Low PPM

Selectivity/Interferants/False Alarms
Not highly selective
Very non-specific, responds to changes in a known vapor concentration.

Response Time
No information available

Start-Up Time
No information available

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION - *Required*

CONSUMABLES - Batteries
WASTE GENERATED - *None*
REPAIRS - with AC adapter, 1-2 times monthly, sensor life 5 years

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

Physical Parameters:
Size
No information available

Weight
Less than 15 kg

Transportability
Human portable

Special Requirements:
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - No information available
MANDATORY SKILL LEVELS - No information available

Interface Requirements
POWER SOURCES - 4 AA batteries
- AC adapter
AUXILIARY EQUIPMENT - No information available

A43 Detector Name
NEOTRONICS OLFACTORY SENSING EQUIPMENT (NOSE)

Description:
Manufacturer
Neotronics Scientific, Inc.
P.O. Box 2100
Flowery Branch, GA 30542
800-535-0606 (TEL)
(770) 967-1854 (FAX)

Technology
Thermal and Electrical Conductivity

Type
- Detects vapor and aerosols

National Stock Number
No information available

Operational Parameters:
Agent Detection
No information available

Sensitivity
General detection limit – 0.01-1 ppm.

Selectivity/Interferants/False Alarms
Not highly selective
No information available

Response Time
Detects in 120 minutes.

Start-Up Time
No information available

Logistical Parameters:
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Training required*

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES - *None*
WATSE GENERATED - *None*

REPAIRS - No information available

Cost
INITIAL COST - $24,000.00
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
45 x 60 x 60 cm

Weight
15 kg

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - No information available
MANDATORY SKILL LEVELS - No information available

Interface Requirements
POWER SOURCES - AC powered, uses only a few Watts
AUXILIARY EQUIPMENT - No information available

A44 Detector Name
MIRAN SAPPHIRE

Description:
Manufacturer
The Foxboro Company
Attn: John J. Malone
Sales Support Specialist
P.O. Box 500
East Bridgewater, MA
(508) 378-5556 (TEL)
(508) 378-5505 (FAX)

Technology
Infrared spectroscopy

Type
- Commercial
- Detects vapors and *aerosols*

National Stock Number
NA

Operational Parameters:
Agent Detection
HD, GB, and VX

Alarm
None

Sensitivity
Sub-ppm and ppb detection, *with built in White cell,* (Optional detector provides at least 3X sensitivity improvement)

Selectivity/Interferants/False Alarms
Highly Selective
Selectivity based on unique infrared spectrum

Response Time
Less than 1 minute

Start-Up Time
Less than 5 minutes

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION/REPAIR – *Baseline spectrum required*
CONSUMABLES – *Liquid nitrogen for the optional detector, replacement rechargeable battery*
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
Roughly the size of a large brief case

Weight
8.2 kg

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note the IR source is probably a glow bar and may be a hazard in an explosive gas environment.*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES – *Battery powered*
AUXILIARY EQUIPMENT - No information available

A45 Instrument Name
CHEMICAL BIOLOGICAL MASS SPECTROMETER (CBMS)

DESCRIPTION
Manufacturer
Bruker Instruments, Inc.
Manning Park, 19 Fortune Drive
Billerica, MA 01821-3991
(508) 667-9580 (TEL)
(978) 667-5993 (FAX)

Technology
Pyrolysis Ion Trap Mass Spectrometer

Type
- Military
- Detects aerosols and contaminated ground

National Stock Number
Not yet assigned

OPERATIONAL PARAMETERS
Agent Detection
Detects GB, VX, and HD.
Detection capability expected to be similar to that of the EM640

Alarm
No information available

Sensitivity
Detects GB at < 0.07 ug/l
Detects VX at < 0.03 ug/l
Detects HD at < 0.09 ug/l

Selectivity/Interferants/False Alarms
Highly selective
< 1:72 Hours – subjective interferents not available

Response Time
≈ 15 seconds

Start-Up Time
No information available

LOGISTICAL PARAMETERS
Ease of Operation

SKILL LEVEL - Technical specialist
TRAINING - Formal training required

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES - No information available
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - CBMS Chassis - $175,000
- Aerosol Probe - $ 35,000
- Ground Probe - $ 11,000

ANNUAL COST - No information available

<u>PHYSICAL PARAMETERS</u>
Size
34.29 x 44.45 x 52.07 cm
(44 x 34 x 52 cm)*

Weight
40 kg

Transportability
The CBMS is to be transported within the BIDS and NBCRS

<u>SPECIAL REQUIREMENTS</u>
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - Training is required
MANDATORY SKILL LEVELS - Must be a trained, chemical specialty soldier

Interface Requirements
POWER SOURCES - External Power Sources (Vehicle / Generator)
AUXILIARY EQUIPMENT - System Components - The CBMS includes a mass analyzer capable of tandem mass spectrometry (ms/ms), a transfer line/pyrolyzer which pyrolysis aerosol materials prior to mass spectral analysis, and a personal computer. In BIDS applications, the CBMS will be linked to the BIDS central computer and will interface to a BIDS aerosol sampling device. In NBCRS applications, the CBMS will support a ground probe which will be used to detect chemical agents during reconnaissance applications.

The CBMS can be used as an independent point detector or it can be incorporated in the NBCRS or the MICAD.

A46 Detector Name
MASS-SPECTROMETER-ON-CHIP (MSOC) ("HANDHELD" MASS SPEC, "PORTABLE" MASS SPEC)

Description:
Manufacturer
Westinghouse Electronic System
Attn: Jeffery A. Leavitt
P.O. Box 1521/MS 3K21
Baltimore, MD 21203
(410) 765-7418 (TEL)
(410) 993-7556 (FAX)

Technology
Mass spectrometry

Type
- Detects vapors

National Stock Number
No information available

Operational Parameters:
Agent Detection
Detects HD, GB, and VX.

Alarm
No information available

Sensitivity
Highly sensitive below TWA – 8 levels

Selectivity/Interferants/False Alarms
Highly selective

Response Time
Less than 5 minutes

Start-Up Time
No information available

Logistical Parameters:
Ease of Operation
SKILL LEVEL – *Technical background*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES - No information available
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

Physical Parameters:
Size
No information available

Weight
14 kg

Transportability
Human portable

Special Requirements:
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - No information available
MANDATORY SKILL LEVELS - No information available

Interface Requirements
POWER SOURCES - Battery powered
AUXILIARY EQUIPMENT - No information available

A47 Detector Name
Pragmatic Model 923
Pragmatic Model 626

DESCRIPTION
Manufacturer
Pragmatics, Inc.
Attn: Richard Motsinger
P.O. BOX 737
Manchester, MO 63011
(314) 225-6786 (TEL)
(314) 225-6786 (MANUAL FAX)

Technology
Semi-conduction sensor

Type
- Commercial
- Detects vapors

National Stock Number
NA

OPERATIONAL PARAMETERS
Agent Detection
Detects GB, VX, and HD

Alarm
Audio and visual

Sensitivity
Low ppm

Selectivity/Interferants/False Alarms
No information available
Not highly selective

Response Time
Less than 1 minute

Start-Up Time
Less than 1 minute

LOGISTICAL PARAMETERS
Ease of Operation
SKILL LEVEL - Technical background

TRAINING - No formal training

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES - *None*
WASTE GENERATED - *None*
REPAIRS - No Information Available

Cost
INITIAL COST - Model 923 $1,520
- Model 626 $775
ANNUAL COST - *$200*

<u>PHYSICAL PARAMETERS</u>
Size
Hand held approximately 15 x 15 x 25 cm

Weight
< 5 kg

Transportability
Human portable

<u>SPECIAL REQUIREMENTS</u>
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCE - Battery Powered
AUXILIARY EQUIPMENT – *None*

A48 Detector Name
SCX-20 VOC MONITOR

DESCRIPTION
Manufacturer
Spectrex Corporation
3580-T Haven Avenue
Redwood City, Ca 94063-4603
(650) 365-6567 (TEL)
(650) 365-5845 (FAX)

Technology
Semi-Conductor

Type
- Commercial
- Detects vapors

National Stock Number
NA

OPERATIONAL PARAMETERS
Agent Detection
Detects GB

Alarm
Visible

Sensitivity
Detects AC at 5 ppm (Typical)

Selectivity/Interferants/False Alarms
Not highly selective
Detects all volatile organic compounds specific with charcoal tube detector.

Response Time
Detects GB in 60 seconds

Start-Up Time
10 seconds

Logistical Parameters
Ease of Operation
SKILL LEVEL - Average, -*technical background*
TRAINING - Good manual, -*no formal training*

Maintainability/Supportability
CALIBRATION - With standard gasses
CONSUMABLES - None
WASTE GENERATED - None
REPAIRS - Rapid service by Spectrex

Cost (initial cost, maintenance cost, supportability cost, training cost)
INITIAL COST - $1,600.00 and minimal training cost
ANNUAL COST - $100 to $200/year for maintenance and $100/year for support

PHYSICAL PARAMETERS

Size
11.68 x 10.66 x 6.09 cm

Weight
0.91 kg

Transportability
Human portable, clips onto belt

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES - 12V DC or 110V AC
AUXILIARY EQUIPMENT - None

Stand-off Detectors and Alarms

B1 Detector Name
M21 REMOTE STANDOFF CHEMICAL AGENT ALARM
M21 REMOTE SENSING CHEMICAL AGENT ALARM (RSCAAL)

DESCRIPTION
Intellitec (Formerly Brunswick Corporation)
2000 Brunswick Lane
Deland, Fl 32724
(904) 736-1700 (TEL)
(904) 736-2250 (FAX)

Technology
The M21 Alarm is an automatic, scanning Passive Fourier Transform Infrared (FTIR) Spectrometer .

Type
- Military
- Detects vapors and aerosols

National Stock Number
6665-01-324-6637

OPERATIONAL PARAMETERS
Agent Detection
Detects GB, VX, and HD.

Alarms
Yes

Sensitivity
Detects nerve agents at 90 Cl (Concentration x Path length).
Detects GB at 90 Cl.
Detects HD at 4500 Cl.

Selectivity/Interferants/False Alarms
Highly selective
The M21 is "trained" to recognize agent in the presence of most common battlefield interferants. However, large quantities of military Halon (a fire suppressant) and organophosphorus insecticides could cause a false positive. Water vapors, and other compounds structurally similar to agent may cause interferants.

Response Time
The M21 will respond within one to five minutes of an attack within the observed sector and up to five kilometers distant. (one minute or less (in one field of view) providing the Cl product exceeds its threshold)

Start-Up Time
Between 3 to 10 minutes *(does not include initial set up time)*

LOGISTICAL PARAMETERS

Ease of Operation
SKILL LEVEL - *Technical background/ Technical specialist*
TRAINING - Formal training required. The army's operator is MOS 54B L5, trained by the USACMLS. The unit level maintainer is 31 ℧ and the direct support Maintainer is 35 F.

Maintainability/Supportability
CALIBRATION - *Frequent baseline checks*
CONSUMABLES - None
WASTE GENERATED - None
REPAIRS - Bit with isolation and Sub-Assembly

Cost
INITIAL COST - $108,000 in quantity
ANNUAL COST - No information available

PHYSICAL PARAMETERS

Size
43.18 x 53.34 x 25.40 cm
(48.26 x 52.07 x 31.75 cm)*

Weight
24 kg

Transportability
The M21 must be transported in its transit case or the XM93E1 mount assembly. When transporting the M21 in the SUSV (only in arctic environments) secured transportation must be used.

Special Requirements

Regulations
INTRINSICALLY SAFE – *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - The army's operator is MOS 54B L5, trained by the USACMLS. The unit level maintainer is 31 ℧ and the direct support maintainer is 35 F.
MANDATORY SKILL LEVELS - No special skills needed

Interface Requirements
POWER SOURCES - 21 VDC to 30 VDC
- A NATO adapter is provided with the system to allow for powering from vehicles.

AUXILIARY EQUIPMENT - System Components

- Detector
- Transit Case
- Tripod bag assembly

B2 Detector Name
AN/KAS-1 CHEMICAL WARFARE DIRECTIONAL DETECTOR
AN/KAS-1A CHEMICAL WARFARE DIRECTIONAL DETECTOR

DESCRIPTION

Manufacturer
Intellitec (Formerly Brunswick Corporation)
2000 Brunswick Lane
Deland, FL 32724
(904) 736-1700 (TEL)
(904) 736-2250 (FAX)

Technology
The AN/KAS-1 is a passive standoff detector utilizing Forward Looking Infrared (FLIR) technology. The AN/KAS-1 uses a selectable filter (one of three available) to enable an operator to interrogate potential threats. By comparing images produced by the filter's three available spectral bands, the operator can distinguish the presence of nerve agent vapor.

The unit has a second function by providing thermal imaging for night surveillance.

Type
- Military
- Detects vapors and aerosols

National Stock Number
AN/KAS-1 (Detector Only) - 5855-01-147-2768
AN/KAS-1 (Detector And Installation Material) - 5855-01-147-4362
AN/KAS-1A (Detector Only) - 5855-01-352-7033
AN/KAS-1A (Detector And Installation Material) - 5855-01-352-7032
PCU - 5855-01-147-2774

OPERATIONAL PARAMETERS

Agent Detection
Detects GB and VX

Sensitivity
Noise equivalent difference temperature (NEDT) 0.12 C 0 – *Dependent on environmental condtions*

Selectivity/Interferants/False Alarms
Highly selective, operator dependent
Water vapors, and other compounds structurally similar to agent may cause interferents. Based on Operator skill and experience.

Response Time
Instantaneous
Based on operator skill and experience and vapor cloud density

Start-Up Time
Less Than 6 minutes *(does not include initial setup)*

LOGISTICAL PARAMETERS

Ease of Operation
SKILL LEVEL – *Technical background/ Technical specialist*
TRAINING - Formal training required

Maintainability/Supportability
CALIBRATION – *Frequent baseline checks*
CONSUMABLES - Lens cleaner, purge gas, lens pads, and lamp kit (6 & 115 V)
WASTE GENERATED - None
REPAIRS - To cooler

Cost
INITIAL COST - Currently not in production cost depends on order size
ANNUAL COST - No information available

PHYSICAL PARAMETERS

Size
SENSOR - 45.7 x 50.8 x 45.7 cm
POWER CONTROL UNIT - 30.5 x 50.8 x 17.8 cm

Weight
SENSOR - 12.7 kg
POWER CONTROL UNIT - 8.2 kg

Transportability
Carrying case is provided for transportation and storage.

Special Requirements

Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING - some training is needed
MANDATORY SKILL LEVELS - Novice

Interface Requirements
POWER SOURCES - 115 Vac, 60 Hz
AUXILIARY EQUIPMENT - System Components
- Power conversion unit

- Sensor

- Support Equipment
  - Carrying case
  - Dry nitrogen purse kit
  - Lens cleaning material

B3 Detector Name
THE AIR SENTRY-FTIR

DESCRIPTION
Manufacturer
Environmental Technologies Group, Inc.
1400 Taylor Avenue
P.O. BOX 9840
Baltimore, MD 21284-9840
800-635-4598 (TEL)
410-321-5325 (FAX)

Technology
The system monitors from 10 to 1,000 meters and eliminates the need for many single point gas specific sensors, calibration requirements, and laboratory analyses. It is capable of detecting, identifying, and quantifying air toxins using infrared Fourier transform spectroscopy

Type
- Detects vapors and aerosols
- Military

National Stock Number
No information available

OPERATIONAL PARAMETERS
Agent Detection
Detects GB, VX, and HD

Sensitivity
Depends on concentration and path length

Selectivity/Interferants/False Alarms
Highly selective, due to unique infrared spectrum of each agent

Response Time
Less than 1 minutes

Start-Up Time
Less than 10 minutes, does not include initial setup

LOGISTICAL PARAMETERS
Ease of Operation
SKILL LEVEL – *Technical background/ Technical specialist*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION – *Frequent baseline checks*
CONSUMABLES – *Possibly purge gas and liquid nitrogen*
WASTE GENERATED - None
REPAIRS - No information available

Cost
INITIAL COST - $98,500.00
MAINTENANCE COST - No information available
SUPPORTABILITY COST - No information available
TRAINING COST - No information available

PHYSICAL PARAMETERS

Size
FOURIER TRANSFORM SPECTROMETER - 61.6 x 47 x 31.12 cm
TELESCOPE - 60.96 x 38.1 cm

Weight
FOURIER TRANSFORM SPECTROMETER - 75 kg

Transportability
Vehicle portable

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - 240 Vac, 4 Amps, 50/60 Hz (Nominal 500 Watts)
AUXILIARY EQUIPMENT - No information available

B4 Detector Name
TRANSFORM SPECTROMETER

Description:
Manufacturer
Bomem Inc.
Hartmann & Braun
Attn: Jean Giroux
Projets Speciaux
450 Av. St-Jean-Baptiste
Quebec, (Quebec) G2E 5S5
Canada
(418) 877-2944 (TEL)
(418) 877-2834 (FAX)
05-31543 (TELEX)

Technology
Fourier Transform Infrared Spectroscopy

Type
- Military
- Commercial
- Detects vapors and aerosols

National Stock Number
No information available

Operational Parameters:
Agent Detection
Detects HD, GB, and VX.

Alarm
Audio and visual

Sensitivity
Depends on concentration and path length

Selectivity/Interferants/False Alarms
Highly selective, due to unique infrared spectrum
Water vapors, and other compounds structurally similar to agent may cause interferents.

Response Time
Less than 10 seconds

Start-Up Time
Less than 10 minutes, does not include initial setup

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – Technical background/ Technical specialist
TRAINING - Formal training
AUTOMATIC OPERATION - Yes

Maintainability/Supportability
CALIBRATION - Requires frequent baseline checks
CONSUMABLES – *May require liquid nitrogen and compressed nitrogen*
WASTE GENERATED – N/A
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
53 x 40.5 x 43 cm

Weight
Nominal weight: 41 kg, possibly less than 20.5 kg

Transportability
Portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - 110-120 VAC
- Battery powered
AUXILIARY EQUIPMENT - No information available

B5 Detector Name
LASER REMOTE DETECTOR

DESCRIPTION

Manufacturer
Research Institute 070 BRNO
Attn: Jiri Kadlcak, PhD
P.O. BOX 547
602 00 BRNO
Czech Republic
420 5 4118 3086/3159 (TEL)
420 5 4118 3152 (FAX)

Technology
Tea CO_2 Dial (LIDAR)

Type
- Military
- Detects vapors and aerosols

National Stock Number
N/A

OPERATIONAL PARAMETERS

Agent Detection
Detects GB and VX.

Alarms
Audio and visual

Sensitivity
GB C x L = 40 mg/m^2
VX C x L = 72 mg/m^2

Selectivity/Interferants/False Alarms
Not highly selective
Theoretically, all agents having strong absorption in the spectral region of the laser beam wavelength could interfere. In the case of an excess of these interferants agents in the atmosphere it is necessary to operate in more wavelength and to mathematically eliminate any influence of interferant agents.

Response Time
30 Seconds

Start-Up Time
20 Minutes, *does not include initial setup*

LOGISTICAL PARAMETERS

Ease of Operation
SKILL LEVEL – Technical Specialist
TRAINING - Formal training

Maintainability/Supportability
CALIBRATION - By the manufacturer
CONSUMABLES - Helium, carbon dioxide and nitrogen gas
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - less than 0.5 million dollars
ANNUAL COST - No information available

PHYSICAL PARAMETERS

Size
100 x 75 x 80 cm

Weight
90 kg

Transportability
Vehicle portable

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE – *Note CO_2 lasers are not visible and are hazardous to the unprotected eye*
REQUIRED LICENSES - None
MANDATORY TRAINING - No information available
MANDATORY SKILL LEVELS - No information available

Interface Requirements
POWER SOURCES - Battery powered, house current, or small generator
AUXILIARY EQUIPMENT – No information available

Analytical Instruments

C1 Instrument Name
QUANTUM 300

DESCRIPTION
Manufacturer
ABB Process Analytical
P.O. Box 831
Lewisburg, Va 24901
(304) 647-4358 (TEL)
(304) 645-4236 (FAX)

Technology
Quadruple Mass Spectrometry

Type
Commercial

National Stock Number
NA

OPERATIONAL PARAMETERS
Agent Detection
Detects GB, VX, and HD

Alarm
None

Sensitivity
Below TWA – 8 levels

Selectivity/Interferants/False Alarms
Highly selective with proper sample preperation

Response Time
Less than 10 minutes

Start-Up Time
Less than 10 minutes, does not include initial setup

LOGISTICAL PARAMETERS
Ease of Operation
SKILL LEVEL – *Technical specialist*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION – *Required*

CONSUMABLES - No information available
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

PHYSICAL PARAMETERS

Size
No information available

Weight
No information available

Transportability
Not transportable

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES – *House current, 220 V*
AUXILIARY EQUIPMENT - No information available

C2 Instrument Name
DYCOR QUADLINK

DESCRIPTION
Manufacturer
Ametek
Process and Analytical Inst. Div.
150 Freeport Rd.
Pittsburgh, PA 15238
(412) 828-9040 (TEL)
(412) 826-0399 (FAX)

Technology
Quadruple Mass Spectrometry

Type
- *Commercial*

National Stock Number
NA

OPERATIONAL PARAMETERS
Agent Detection
Manufacturer does not guarantee detection of CW agents

Alarm
None

Sensitivity
Below TWA – 8 levels

Selectivity/Interferants/False Alarms
Highly selective

Response Time
Less than 10 minutes

Start-Up Time
Less than 10 minutes, does not include initial setup

LOGISTICAL PARAMETERS
Ease of Operation
SKILL LEVEL - *Technical specialist*
TRAINING - *Formal training required*

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES - No information available
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

PHYSICAL PARAMETERS

Size
No information available

Weight
No information available

Transportability
Not transportable

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS – *None*

Interface Requirements
POWER SOURCES – *House current, 220 V*
AUXILIARY EQUIPMENT - Remote computer control.

<u>C3 Instrument Name</u>
CUB 800

<u>DESCRIPTION</u>
Manufacturer
Bear Instruments, Inc.
3645 Enochs Street
Santa Clara, Ca 95051
(408) 773-0461 (TEL)
(408) 773-0463 (FAX)

Technology
MS/MS system electron ionization or chemical ionization. Three quadrapoles

Type
- Commercial
- Analyzes vapors, aerosols, *and liquids*

National Stock Number
N/A

<u>OPERATIONAL PARAMETERS</u>
Agent Detection
Detects GB, VX, and HD

Alarm
None

Sensitivity
General detection in low ppb, (these agents have not been specifically tested)

Selectivity/Interferents/False Alarms
Highly selective
No specific interferents

Response Time
Milliseconds – *Less than 60 seconds*

Start-Up Time
10 Minutes

<u>LOGISTICAL PARAMETERS</u>
Ease Of Operation
SKILL LEVEL - Technical specialist
TRAINING – Formal training required

Maintainability/Supportability
CALIBRATION - Self calibrating, once a month
CONSUMABLES - 2-year life for pump, filaments, reagent gasses for some types of analysis.
WASTE GENERATED - None
REPAIRS - Maintenance necessary only once every two years should be done by the manufacturer.

Cost
INITIAL COST - $120,000
ANNUAL COST - $5000/Year

PHYSICAL PARAMETERS
Size
46 x 54 x 36 cm

Weight
55 kg

Transportability
Two person portable

Special Requirements
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING - Provided by manufacturer during installation
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES - House current
AUXILIARY EQUIPMENT - None required

C4 INSTRUMENT NAME
API 365

DESCRIPTION
Manufacturer
Pe Sciex
71 Four Valley Drive
Concord, Ontario, Canada
L4K4V8
(905)-660-9005 (TEL)

Technology
Atmospheric pressure ionization triple quadruple mass spectrometry.

Type
- Commercial
- Detects vapors and aerosols

National Stock Number
No information available

OPERATIONAL PARAMETERS
Agent Detection
Detects GB, VX, and HD

Alarm
None

Sensitivity
- Detects GB at < 10 ng/m^3
- Detects VX at <10 ng/m^3
- Detects HD at <50 ng/m^3

Selectivity/Interferants/False Alarms
Highly selective
Very specific in MS/MS mode.

Response Time
Detects in <5 seconds.

Start-Up Time
20 minutes

LOGISTICAL PARAMETERS
Ease of Operation

SKILL LEVEL - Technical specialist
TRAINING - Formal Training

Maintainability/Supportability
CALIBRATION - User
CONSUMABLES - Yes
WASTE GENERATED - Yes
REPAIRS - Manufacturer or trained user

Cost
INITIAL COST - $280,000, free training with purchase for two people
ANNUAL COST - No information available

PHYSICAL PARAMETERS
Size
50.8 x 134.62 x 54.61 cm

Weight
102 kg

Transportability
Vehicle portable

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING - No information available
MANDATORY SKILL LEVELS - No information available

Interface Requirements
POWER SOURCES - 120 VAC
AUXILIARY EQUIPMENT - No information available

C5 Instrument Name
HP 5973 MSD

DESCRIPTION

Manufacturer
Hewlett-Packard Co.
Attn: Mr. Bill Arnold
3701 Koppers Street
Baltimore, MD 21227
(410) 362-7594 (TEL)
(410) 362-7650 (FAX)

Technology
Quadruple MS

Type
- Commercial
- Detects Liquids, Vapors, And Aerosols

National Stock Number
N/A

OPERATIONAL PARAMETERS

Agent Detection
Detects GB, VX, and HD

Alarm
Audio and visual

Sensitivity
0.1 TWA for all agents

Selectivity/Interferants/False Alarms
Highly selective
No interferants

Response Time
3 to 5 minutes

Start-Up Time
4 hours

LOGISTICAL PARAMETERS

Ease of Operation
SKILL LEVEL - Technical specialist

TRAINING - Manufacturer training

Maintainability/Supportability
CALIBRATION - Self calibrating with standards
CONSUMABLES - Chromatography supplies
WASTE GENERATION - None
REPAIRS - Done by manufacturer

Cost
INITIAL COST - $75,000
ANNUAL COST - $5,000/Year for maintenance and $3,000/year for support

PHYSICAL PARAMETERS
Size
GC/MS - 50 x 65 x 85 cm
Chem station - 71 x 112 cm

Weight
Approximately 125 kg for entire system

Transportability
2 human portable in "fly away" case

SPECIAL REQUIREMENTS
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES - 110 VAC, 20 Amp.
AUXILIARY EQUIPMENT - None

C6 Instrument Name
HP 6890

DESCRIPTION
Manufacturer
Hewlett-Packard Co.
Attn: Mr. Bill Arnold
3701 Koppers Street
Baltimore, MD 21227
(410) 362-7594 (TEL)
(410) 362-7650 (FAX)

Technology
Gas Chromatograph with Flame Photometry Detection

Type
- Commercial
- Detects liquids, vapors, and aerosols

National Stock Number
N/A

OPERATIONAL PARAMETERS
Agent Detection
Detects GB, VX and HD

Alarms
Audible and visual

Sensitivity
< 0.1 TWA for all agents

Selectivity/Interferants/False Alarms
Highly selective
Interferents separated out by GC

Response Time
3 to 5 minutes

Start-Up Time
2 hours

Logistical Parameters
Ease of Operation
SKILL LEVEL - Technical Specialist

TRAINING – Formal training required

Maintainability/Supportability
CALIBRATION - Yes, with standards
CONSUMABLES - Chromatography supplies
WAIST GENERATED - None
REPAIRS - Manufacturer

Cost
INITIAL COST - $30,000 + $2,00 for off sight training
ANNUAL COST - $2,000/Year for maintenance + $1,000/Year for support

PHYSICAL PARAMETERS
Size
50 x 58 x 50 cm

Weight
Approximately 75 kg for the system

Transportability
2 Human portable

SPECIAL REQUIREMENTS
Regulations
INTRINSICALLY SAFE – *Note the detector produces a flame and the fueled by a compressed hydrogen gas bottle*
REQUIRED LICENSES - None
MANDATORY TRAINING - None
MANDATORY SILL LEVELS - None

Interface Requirements
POWER SOURCES - 110 VAC
AUXILIARY EQUIPMENT - None

<u>C7 Instrument Name</u>
AUTOMATIC CONTINUOUS AIR MONITORING SYSTEM (ACAMS)

<u>DESCRIPTION</u>
Manufacturer
Abb Process Analytics
Attn: Dan Romero
Vp/General Manager Subcontracting
843 North Jefferson St.
P.O. Box 843
Lewisburg, Wv 24901
(304) 647-1709 (TEL)
(304) 645-4988 (FAX)

Technology
The ACAMS is an automated Gas Chromatograph that first collects agent on a solid sorbent and then thermally desorbs the agent into a separation column for analysis. The components eluting from the column are detected by a Flame-Photometric Detector, which can respond to compounds containing either phosphorous (i.e., GB or VX) or sulfur (HD). The ACAMS consists of a monitor, strip-chart recorder, sample pump and computer interface.

Type
- Military
- Commercial
- Detects Vapors And Aerosols

National Stock Number
None

<u>Operational Parameters</u>
Note: Performance Described In Following Section Has Been Established And Verified By The Department of the Army, Office Of The Program Manager For Chemical Demilitarization.

Agent Detection
Detects HD, GB, and VX.

Alarm
Audio and visual

Sensitivity
Detects HD at 0.003 mg/m^3.
Detects GB at 0.0001 mg/m^3.
Detects VX at 0.00001 mg/m^3.

Selectivity/Interferants/False Alarms
Not highly selective
Some ambient volatile compounds. Also, some organic compounds.

Response Time
TWA concentrations of GB or HD – 3 minutes
TWA concentrations of VX – 5 minutes
IDLH concentrations of GB, VX, and HD – 2 minutes

Start-Up Time
One or two days for equipment to become operational from a cold start.

LOGISTICAL PARAMETERS

Ease of Operation
SKILL LEVEL - *Technical specialist*
TRAINING - Formal training required

Maintainability/Supportability
CALIBRATION - User
CONSUMABLES - Yes
WASTE GENERATED - None
REPAIRS - User

Cost
INITIAL COST - Contact manufacturer
ANNUAL COST - Contact manufacturer

PHYSICAL PARAMETERS

Size
ACAMS Monitor - 43.18 x 48.26 x 22.86 cm
Recorder - 27.94 x 17.78 x 12.7 cm
Sample Pump - 45.72 x 15.24 x 15.24 cm
Computer Interface - 15.24 x 17.78 x 12.7 cm

Weight
Total weight is approximately 154 kg

Transportability
Equipment is vehicle portable

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE – *Note the detector produces a flame and is fueled by a compressed hydrogen gas bottle, the GC also uses a compressed gas bottle*
REQUIRED LICENSES - No information available
MANDATORY TRAINING - No information available

MANDATORY SKILL LEVELS - No information available

Interface Requirements

POWER SOURCES - Power requirements are 115 Vac approximately 600 watts,
AUXILIARY EQUIPMENT - Support gases (hydrogen, nitrogen, and air) required.

C8 Instrument Name
DUAL FLAME PHOTOMETRIC DETECTOR

DESCRIPTION
Manufacturer
SRI Instruments Inc.
Attn: Hugh Goldsmith
20720 Earl St.
Torrance, Ca 90503
(310) 214-5092 (TEL)
(310) 214-5097 (FAX)

Technology
Gas chromatography with flame photometry detection

Type
- Commercial
- Detects vapors, aerosols, *and liquids*

National Stock Number
NA

OPERATIONAL PARAMETERS
Agent Detection
Detects HD, GB, and VX.

Alarms
Audio and visual

Sensitivity
1 ppb with concentrator
1 ppm without concentrator

Selectivity/Interferants/False Alarms
Highly selective, dependent on chromatography column used
Sulfur gases could cause interference

Response Time
1 to 10 minutes

Start-Up Time
20 minutes

LOGISTICAL PARAMETERS
Ease of Operation
SKILL LEVEL - Technical specialist

TRAINING - Formal training

Maintainability/Supportability
CALIBRATION - User
CONSUMABLES – *Compressed gasses*
WASTE GENERATED - None
REPAIRS - Manufacturer

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

PHYSICAL PARAMETERS

Size
8610 GC Series 49.53 x 36.83 x 31.75 cm
310 GC Series 31.75 x 36.83 x 31.75 cm

Weight
8610 GC Series 88-154 kg depending on configuration
3110 GC Series 66-110 kg depending on configuration

Transportability
Portable

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE – *Note the detector produces a flame, fueled by a compressed hydrogen gas bottle and the GC also uses compressed gas bottles*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - 120 VAC or 220 VAC, or operated from generator or inverter
AUXILIARY EQUIPMENT - No information available

C9 Instrument Name
EKHO

DESCRIPTION

Manufacturer
Mine Safety Appliances Co. (MSA)
Attn: Stanley S. Gross
Cranberry Instrument Division
P.O. Box 427
Pittsburg, PA 15230-0427
(412) 776-8822 (TEL)
(412) 776-8892 (FAX)

Technology
Gas chromatography

Type
- Commercial
- Detects vapors and aerosols

National Stock Number
NA

OPERATIONAL PARAMETERS

Agent Detection
Detects *GB, VX, and HD*

Alarms
Audio and visual

Sensitivity
High sensitivity, below TWA – 8 levels

Selectivity/Interferants/False Alarms
Highly selective, dependant on chromatography column used.

Response Time
Less than 60 minutes

Start-Up Time
Less than 10 minutes, does not include initial setup

LOGISTICAL PARAMETERS

Ease of Operation
SKILL LEVEL - *Technical specialist*
TRAINING - *Formal training required*

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES - *Carrier gasses*
WASTE GENERATED - None
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

PHYSICAL PARAMETERS

Size
No information available

Weight
< 66 kg

Transportability
Portable

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE – *Note the GC uses compressed gas bottles*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - Battery Powered
AUXILIARY EQUIPMENT – No information available

C10 Instrument Name
PHOTOVAC SNAPSHOT HAND HELD GAS CHROMATOGRAPH

DESCRIPTION

Manufacturer
Photovac International Inc.
Attn: Joyce Austin
25-B Jefryn Blvd.
West Deer Park, Ny 11729
(516) 254-4199 (TEL)
(516) 254-4284 (FAX)

Technology
Gas Chromatography

Type
- Commercial
- Detect vapors and aerosols

National Stock Number
NA

OPERATIONAL PARAMETERS

Agent Detection
Has not been tested against CWA

Alarms
Audio and visual

Sensitivity
High sensitivity, below TWA – 8 levels

Selectivity/Interferants/False Alarms
Highly selective, dependant on chromatography column used.

Response Time
Less than 60 minutes

Start-Up Time
Less than 10 minutes, does not include initial setup

LOGISTICAL PARAMETERS

Ease of Operation
SKILL LEVEL - *Technical specialist*
TRAINING - *Formal training required*

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES - *Carrier gasses*
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

PHYSICAL PARAMETERS
Size
No information available

Weight
< 10 kg

Transportability
Human portable

SPECIAL REQUIREMENTS
Regulations
INTRINSICALLY SAFE – *Note the GC probably uses a compressed gas bottle*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements (power sources, auxiliary equipment)
POWER SOURCES - Battery powered
AUXILIARY EQUIPMENT – No information available

C11 Instrument Name
SCENTOSCREEN (GAS CHROMATOGRAPH) WITH ARGON IONIZATION DETECTOR

DESCRIPTION

Manufacturer
Sentex Systems Inc.
Attn: Dr. Amos Linenberg
553 Broad Ave.
Ridgefield, NJ 07657
(201) 945-3694 (TEL)
(201) 941-6064 (FAX)

Technology
Gas chromatograph with argon Ionization Detector (AID) provides sensitive detection of organic compound having an ionization potential of 11.7 cv or below.

Type (Military, Commercial And Liquid, Vapor, Aerosol)
- Commercial
- Detects vapors and aerosols, and liquids

National Stock Number
None

OPERATIONAL PARAMETERS

Agent Detection
Detects HD, GB, and VX.

Alarms
Audio and visual

Sensitivity
HD has been tested at 10 ppb
GB has been tested at 3.5 ppb
No data is available for VX

Selectivity/Interferants/False Alarms
Highly selective, dependent on chromatography column used
Selectivity good, molecules with an identical retention time as the agents can act as interferants.

Response Time
Less than 2 minutes

Start-Up Time
30 minutes to equilibrate from a cold start

LOGISTICAL PARAMETERS

Ease of Operation

SKILL LEVEL - *Technical specialist*
TRAINING - Formal training required

Maintainability/Supportability

CALIBRATION - Recommended every 12 hours
CONSUMABLES - Argon gas (ultra high purity), syringes, tedlar bags, and water vials.
WASTE GENERATED - This is a non-destructive instrument so the exhaust stream contain agent.
REPAIRS - No information available

Cost

INITIAL COST - $17,525 plus $950 + costs for on-sight training (free training at factory)
ANNUAL COST - 1,000/Year + 8% of purchase price/year for technical support

PHYSICAL PARAMETERS

Size

16.51 x 34.29 x 49.53 cm

Weight

22 kg

Transportability

Human portable

SPECIAL REQUIREMENTS

Regulations

INTRINSICALLY SAFE – Note the GC and detector require high pressure compressed gas bottles
REQUIRED LICENSES - None
MANDATORY TRAINING - Yes (by Sentex)
MANDATORY SKILL LEVELS - Technical

Interface Requirements

POWER SOURCES - Battery powered
AUXILIARY EQUIPMENT - Supplied with battery charger

<u>C12 Instrument Name</u>
MM-1 MOBILE MASS SPECTROMETER

DESCRIPTION

Manufacturer
Bruker-Franzen Analytik Gmbh
Germany

Technology
GC/Quadruple Mass Spec.

Type
- Military
- Detects *liquids, vapors and aerosols*

National Stock Number
No information available

OPERATIONAL PARAMETERS

Agent Detection
Detects GB, VX, and HD.

Alarm
No information available

Sensitivity
Overall > 10 mg/m^2 for surface monitoring
Below TWA - levels

Selectivity/Interferants/False Alarms
Highly selective
Extremely low interference.

Response Time
Detects in 5 – 200 Seconds.

Start-Up Time
No information available

LOGISTICAL PARAMETERS

Ease of Operation
SKILL LEVEL - *Technical specialist*
TRAINING - *Formal training required*

Maintainability/Supportability
CALIBRATION - *Required*

CONSUMABLES - *Bottled gasses*
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

<u>PHYSICAL PARAMETERS</u>
Size
No information available

Weight
No information available

Transportability
Not transportable

<u>SPECIAL REQUIREMENTS</u>
Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - No information available
MANDATORY SKILL LEVELS - No information available

Interface Requirements
POWER SOURCES - *House current 220 VAC*
AUXILIARY EQUIPMENT - No information available

C13 Instrument Name
VIKING SPECTRA TRAK 572

DESCRIPTION
Manufacturer
Viking Instruments Corp.
3800 Concorde Park Way, Suite 1500
Chantilly, VA 20151
(703) 968-0101 (TEL)
(703) 968-0166 (FAX)

Technology
GC/MS
Gas chromatograph with quadruple mass spectrometry detection. Internal sub ambient cooling for volatile organic compounds. Built in sorbent trap and desorber, real-time membrane interface.

Type
- Military
- Commercial
- Detects samples of liquid, gas and air

National Stock Number
No information available

OPERATIONAL PARAMETERS
Agent Detection
Detects GB, VX, and HD

Alarm
None

Sensitivity
Picogram to femtogram

Selectivity/Interferants/False Alarms
Highly selective
Very selective mass spectrometry, “finger prints” chemicals based on unique chemical structure, combined with GC nearly eliminates interferent effects and false alarms.

Response Time
Method specific

Start-Up Time
15 to 30 minutes

LOGISTICAL PARAMETERS

Ease of Operation
SKILL LEVEL - *Technical specialist*
TRAINING - Formal training is required

Maintainability/Supportability
CALIBRATION - Standards required for calibration
CONSUMABLES - Gas supply, septa, and GC columns
WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - $95-115k plus 8% service contract
ANNUAL COST - No information available

PHYSICAL PARAMETERS

Size
46 x 61 x 29 cm

Weight
39 kg (without the roughing pump, keyboard and monitor)

Transportability
Designed for transportability in optional shipping case

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE – *Note the GC uses a compressed gas bottle*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - Some training is required
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - 110 VAC, 1200 W Transient, 650 W Average.
AUXILIARY EQUIPMENT - System Components

- Computer – an integral full-function system, MS-DOS compatible with Microsoft Windows 3.1 interface is used to control instrument operation and perform various types of data analyses
- Transport Case – the case is weatherproof with rubber boot behind the front panel. All components with the exception of the roughing

pump are inside the case. The GC/MS are mounted on a shock-resistant internal chassis.

- Support Equipment
  - optional model available for remote data transfer

C14 Instrument Name
SATURN

DESCRIPTION
Manufacturer
Varian Chromatography Systems
505 Julie Rivers Rd. # 150
Sugarland, Tx 77478
(800) 926-3000 (TEL)
(281) 240-6752 (FAX)

Technology
Gas chromatograph with ion trap mass spectrometer operating in electron ionization, chemical ionization or MS/MS modes

Type
- Commercial
- Detects Liquids and Vapors

National Stock Number
NA

OPERATIONAL PARAMETERS
Agent Detection
Detects GB, VX, and HD

Alarm
None

Sensitivity
Below TWA – 8 levels

Selectivity/Interferants/False Alarms
Highly selective
Little interference, low probability of false alarms.

Response Time
Approximately 30 minutes after injection of sample

Start-Up Time
0.5 to 8 hours depending on the sensitivity required.

LOGISTICAL PARAMETERS
Ease Of Operation
SKILL LEVEL - Technical specialist
TRAINING - Formal training required or experience with GC/MS

Maintainability/Supportability
CALIBRATION - Required, varies daily to weekly
CONSUMABLES - Ultra pure helium, standards, and lab ware
WASTE GENERATED - Sample prep waist if any
REPAIRS - Qualified Varian engineer for other than routine maintenance.

Cost
INITIAL COST - $65-82k plus Operator Training course $1,800/week/person for operator course ($1,440/day on sight)
ANNUAL COST - $4,200/year for maintenance

PHYSICAL PARAMETERS

Size
121.92 x 60.96 x 55.88 cm

Weight
Approximately 70 kg

Transportability
Mobile lab

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE – *Note the GC uses compressed gas bottles*
REQUIRED LICENSES - None
MANDATORY TRAINING - Operators course
MANDATORY SKILL LEVELS - Experience with GC and GC/MS

Interface Requirements
POWER SOURCES - 110 VAC, 20 Amp
AUXILIARY EQUIPMENT - Ultra pure helium in tank and miscellaneous lab ware.

C15 Instrument Name
HP 2350 A ATOMIC EMISSION DETECTOR

DESCRIPTION

Manufacturer
Hewlett-Packard Co.
Attn: Mr. Bill Arnold
3701 Koppers Street
Baltimore, MD 21227
(410) 362-7594 (TEL)
(410) 362-7650 (FAX)

Technology
GC/AED

Type
- Commercial
- Detects vapors and aerosols liquid injection

National Stock Number
N/A

OPERATIONAL PARAMETERS

Agent Detection
Detects HD, GB, and VX.

Alarm
Audio and visual

Sensitivity
0.2 TWA for all agents, 5 liter sample

Selectivity/Interferants/False Alarms
Highly selective
100 % selective no interferents

Response Time
3 to 5 minutes

Start-Up Time
4 to 6 hours

LOGISTICAL PARAMETERS

Ease Of Operation
SKILL LEVEL - Technical specialist
TRAINING - Formal training

Maintainability/Supportability
CALIBRATION - Calibration with standards
CONSUMABLES - Bottled gas and other GC consumables
WASTE GENERATED - None
REPAIRS - Done by manufacturer

Cost
INITIAL COST - $80,000 plus $10k for on sight training ($2k for off sight)
ANNUAL COST - $6,000/Year plus $3,000/Year for support

PHYSICAL PARAMETERS
Size
57 x 52 x 41 cm

Weight
Entire unit approximately 115 kg

Transportability
2 man portable

SPECIAL REQUIREMENTS
Regulations
INTRINSICALLY SAFE **–** *Note the detector produces a flame and required compressed gasses, the GC also uses compressed gas bottles*
REQUIRED LICENSES - None
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES - 110 Vac, 20 Amp.
AUXILIARY EQUIPMENT - No information available

<u>C16 Instrument Name</u>
INFRARED DETECTOR FOR GAS CHROMATOGRAPH

DESCRIPTION

Manufacturer
Biorad, Digilab Division
237 Putnam Ave.
Cambridge, MA 02139
(800) 225-1248 (TEL)

Technology
This is a “light pipe” system that analyzes GC effluent in a gaseous form by infrared spectroscopy

Type
- Comercial
- Detects gas output form a gas chromatograph

National Stock Number
None, but is on GSA contact

OPERATIONAL PARAMETERS

Agent Detection
Detects GB, VX, and HD
Limited by the attached gas chromatograph.
Can be programmed for alarms

Sensitivity
Will detect nano-gram quantities

Selectivity/Interferants/False Alarms
Highly selective,
No false alarms
It is the only way of determining isomers of specific compounds.

Response Time
Limited by the gas chromatograph

Start-Up Time
0.5 hours

LOGISTICAL PARAMETERS

Ease of Operation
SKILL LEVEL - Technician specialist
TRAINING – Formal training required

Maintainability/Supportability
CALIBRATION - Little or none, *background spectrum of carrier gas*
CONSUMABLES - 4 liters liquid nitrogen/day
WASTE GENERATED – None
REPAIRS - As needed, but generally rugged system

Cost
INITIAL COST - Approx $90,000 complete with compute system and spectral libraries
MAINTENANCE COST - $1,500/tune-up (once per year) + cost of liquid nitrogen

PHYSICAL PARAMETERS

Size
33.02 x 76.2 x 76.2 cm

Weight
53 kg

Transportability
Human portable, limited when hooked to GC

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE – *Note the infrared source is probably a glow bar which may be hazardous in an explosive environment*
REQUIRED LICENSES - Software license
MANDATORY TRAINING - None
MANDATORY SKILL LEVELS - None

Interface Requirements
POWER SOURCES - Two 110 VAC lines with stabilized voltage
AUXILIARY EQUIPMENT - Gas chromatograph, and computer system.

<u>C17 Instrument Name</u>
TRACE ULTRA HIGH SENSITIVITY

<u>DESCRIPTION</u>
Biorad, Digilab Division
237 Putnam Ave.
Cambridge, MA 02139
(617) 868-4330

Technology
Gas Chromatography/Fourier Transform Infrared Spectrometry

Type
- *Commercial*
- Detects vapors, aerosols, *and liquids*

National Stock Number
NA

<u>OPERATIONAL PARAMETERS</u>
Agent Detection
Detects *HD, GB, and VX*

Alarm
None

Sensitivity
High sensitivity, below TWA – 8 levels

Selectivity/Interferants/False Alarms
Highly selective, dependent on chromatography column.

Response Time
Less than 60 minutes

Start-Up Time
Less than 10 minutes, does not include initial setup or oven preheating

<u>LOGISTICAL PARAMETERS</u>
Ease of Operation
SKILL LEVEL - *Technical specialist*
TRAINING - *Formal training required*

Maintainability/Supportability
CALIBRATION - *Required*
CONSUMABLES – *Carrier gasses for GC*

WASTE GENERATED - *None*
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

<u>PHYSICAL PARAMETERS</u>
Size
No information available

Weight
No information available

Transportability
Not transportable

<u>SPECIAL REQUIREMENTS</u>
Regulations
INTRINSICALLY SAFE – *Note the GC requires high pressure compressed gas bottles*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements (power sources, auxiliary equipment)
POWER SOURCES – *House current*
AUXILIARY EQUIPMENT - No information available

C18 Instrument Name
TYPE 1301 GAS ANALYZER

DESCRIPTION

Manufacturer
Bruel & Kjaer
Attn: Michael Vecht
307 Skodsborgvej
Dk-2850 Naerum
Denmark
45 42 800500 (TEL)
45 42 806884 (FAX)
37316 Bruka Dk (TELEX)
Denmark

Technology
The Type 1301 Gas Analyzer is a Fourier Transform Infrared (FTIR) spectrometer with photo acoustic detection designed for on-site and laboratory use as a qualitative analyzer and monitor.

Type
- Commercial
- Detects vapors and aerosols

National Stock Number
NA

OPERATIONAL PARAMETERS

Agent Detection
Detects GB, VX, and HD.

Alarms
None

Sensitivity
Detects GB and VX at 0.1-10 ppm.

Selectivity/Interferants/False Alarms
Highly selective, when set up correctly for the environment
False alarms are dependent on detection frequency range and environmental fluctuations.

Response Time
Less than 2 minutes

Start-Up Time
Less than 10 minutes, does not include initial setup

LOGISTICAL PARAMETERS

Ease of Operation

SKILL LEVEL - *Technical specialist*
TRAINING - *Formal training required*

Maintainability/Supportability

CALIBRATION - built-in self test functions
CONSUMABLES - No information available
WASTE GENERATED - *None*
REPAIRS - No information available

Cost

INITIAL COST - No information available
ANNUAL COST - No information available

PHYSICAL PARAMETERS

Size

No information available

Weight

> 66 kg

Transportability

Not portable

SPECIAL REQUIREMENTS

Regulations

INTRINSICALLY SAFE – *Note the FT-IR may used compressed gas bottles for purging*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements

POWER SOURCES - 90 VAC - 140 VAC
- 180 VAC-264 VAC (47.5 Hz – 66Hz)
- Can be powered by a battery pack with inverter.

AUXILIARY EQUIPMENT – No information available

C19 Instrument Name
RAMAN CHEMICAL ANALYZER

Description:
Manufacturer
Gamma-Metrics
Attn: Dr. Scott Sutherland
5788 Pacific Center Blvd.
San Diego, CA 92121
(619) 450-9811 (TEL)
(619) 452-9250 (FAX)

Technology
Operates using a laser spectroscopic method.

Type
- Commercial
- Detects *liquids and solids*

National Stock Number
No information available

Operational Parameters:
Agent Detection
Has shown positive detection of simulants dmmp and dimp. Has not been tested against agents.

Alarm
None

Sensitivity
Typically high ppb to low ppm (no information on chemical warfare agents)

Selectivity/Interferants/False Alarms
Highly selective
Moderate to high (no information on chemical warfare agents)

Response Time
1-30 seconds

Start-Up Time
Less than 5 minutes

Logistical Parameters:
Ease of Operation

SKILL LEVEL – *Technical specialist*
TRAINING – Formal training required, 4-8 hours max

Maintainability/Supportability
CALIBRATION - User calibration
CONSUMABLES - Laser 10,000 hours, desicant package approximately 1 year
WASTE GENERATED - Small sample holders
REPAIRS - No information available

Cost
INITIAL COST - $30 – 50K
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
Approx. 50 x 35.5 x 15.2 cm

Weight
16 kg

Transportability
Human portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note this instrument uses a low power laser, which may be hazardous to the unprotected eye*
REQUIRED LICENSES - None
MANDATORY TRAINING - Simple laser safety
MANDATORY SKILL LEVELS - None technical only

Interface Requirements
POWER SOURCES - 12 VDC or 120 VAC
- Battery powered
AUXILIARY EQUIPMENT – No information available

<u>C20 Instrument Name</u>
SYSTEM 2000 PROCESS NMR

<u>Description:</u>
Manufacturer
Elbit-Ati Instruments
Attn: Jack Doherty
NMR Sales Manager
501 W. Lake Street, Suite 202
Elmhurst, IL 60126
(708) 993-0800 (TEL)
(708) 993-0825 (FAX)

Technology
Nuclear Magnetic Resonance Spectroscopy

Type
- Commercial
- Detects *in liquid samples*

National Stock Number
No information available

<u>Operational Parameters:</u>
Agent Detection
Detects HD, GB, and VX.

Alarm
Audio and Visual

Sensitivity
Very sensitive below TWA – 8 levels

Selectivity/Interferants/False Alarms
Highly selective

Response Time
Less than 10 minutes

Start-Up Time
Less than 10 minutes, does not include sample preparation

<u>Logistical Parameters:</u>
Ease of Operation
SKILL LEVEL – *Technical specialist*
TRAINING – *Formal training required*

Maintainability/Supportability
CALIBRATION - *Reqired*
CONSUMABLES – *Calibration standards, compressed gas, and batteries*
WASTE GENERATED – Liquid samples
REPAIRS - No information available

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

<u>Physical Parameters:</u>
Size
No information available

Weight
> 66 kg

Transportability
Not portable

<u>Special Requirements:</u>
Regulations
INTRINSICALLY SAFE – *Note NMRs usually contain high field electro-magnets that can be hazardous to people with pace makers*
REQUIRED LICENSES - *None*
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *none*

Interface Requirements
POWER SOURCES - Battery powered – *Most likely house current*
AUXILIARY EQUIPMENT – No information available

C21 Instrument Name
ABSORPTION AIR SAMPLING "BUBBLER"

DESCRIPTION
Manufacturer
No information available

Technology
The bubbler unit is usually a vessel packed with glass beads and filled with a scrubbing solution. The air sample is bubbled through the scrubbing solution, which absorbs the chemical agent from the air sample. After sampling for a predetermined time and flow rate, the unit is removed and sent to a chemical laboratory for processing to determine the presence, type, and quantity of agent in the sample.

Type
- Detects vapors and aerosols (after sample is sent to laboratory)
- *Military*

National Stock Number
No information available

OPERATIONAL PARAMETERS
Agent Detection
Detects HD, GB, and VX. (after sample is sent to laboratory)

Alarm
None

Sensitivity
Detects HD at 0.003 mg/m^3.
Detects GB at 0.00003 mg/m^3.
Detects VX at 0.00001 mg/m^3.

Selectivity/Interferants/False Alarms
Highly selective, when laboratory instruments used to analyze sample

Response Time
Greater than one day

Start-Up Time
Less than 10 minutes

LOGISTICAL PARAMETERS
Ease of Operation
SKILL LEVEL - *Technical specialist*
TRAINING - *No formal training required*

Maintainability/Supportability
CALIBRATION - None
CONSUMABLES - *Bubbler solution*
WASTE GENERATED - *Bubbler solution*
REPAIRS - None

Cost
INITIAL COST - No information available
ANNUAL COST - No information available

PHYSICAL PARAMETERS

Size
No information available

Weight
No information available

Transportability
Human portable

SPECIAL REQUIREMENTS

Regulations
INTRINSICALLY SAFE - *Yes*
REQUIRED LICENSES - None
MANDATORY TRAINING - *None*
MANDATORY SKILL LEVELS - *None*

Interface Requirements
POWER SOURCES - None
AUXILIARY EQUIPMENT - None

Integrated Detection Laboratories

M93A1 FOX Nuclear, Biological, Chemical Reconnaissance System.

The FOX is a six wheeled, 19 ton, armored, amphibious reconnaissance vehicle equipped with a collective protection system for operation in contaminated environments. The FOX is equipped with an M21 stand off detector (detector B1), an M43A1 (detector A12) chemical agent detector, an MM1 mass spectrometer, and several remotely controlled exterior sampling devices that can be controlled from inside the vehicle. The FOX can detect agents in the air, on ground or on items that can be contacted with the sampling arms. It is capable of laying down flags to identify contaminated areas. The FOX requires technical specialists for operation.

Real Time Analytical Platform (RTAP)

The RTAP is a self-contained portable analytical laboratory designed to be used by an emergency response team. The RTAP is designed to monitor the air for contamination down to sub-parts per billion (ppb) concentrations. The RTAP has electrical generators, air purifiers, and gas generators for unsupported operation of the analytical equipment. It contains several sophisticated analytical instruments that require technical specialists for operation.

Mobile Environmental Analytical Platform (MEAP)

The MEAP is a fully functional trailer laboratory equipped with a full compliment of gas chromatographs and detectors. It is designed to monitor chemical warfare agent exposure on personnel, equipment, and the environment including workers breathing zone monitoring. The MEAP is equipped with gas generators and electric generators for independent operation of the analytical equipment. The MEAP requires technical specialists for operation.

Multipurpose Integrated Chemical Agent Alarm (MICAD)

The MICAD is an automated electronic control station. It can collect the alarm signal from a series of remotely placed alarms. The alarm signal or signals are processed by the MICAD, which is programmed to respond accordingly. The alarm signals can be digitally transmitted to command centers and adjacent locations. When used in a vehicle or in shelters the MICAD can initiate collective protection for those areas at risk of contamination. The MICAD can operate unattended using several different power supplies. The MICAD requires a technical specialist for set up and maintenance. The MICAD is compatible with almost all of the listed alarms and monitors that can operate remotely.

Future CWA Detection Technology

Advances in the state-of-the-art analytical chemistry and biosensor technology may provide a source of new technologies for improved CWA detectors in the coming years. Much of the research currently being conducted is aimed at improving current technologies, as opposed to developing novel technologies. Improved CWA detectors should be lighter, smaller, less expensive, more sensitive, and more selective.

A new technology that is undergoing significant development is biosensor detection. Biosensors use agent specific antibodies and enzymes that will bind only to a specific agent allowing it to be removed from the sample, concentrated, and then detected (usually through a colormetric technique). Some biosensors may be able to bind to the agent and chemically react with or catalyze a reaction through the use of agent specific enzymes. If the reaction products from the breakdown of the agent can be detected electrochemically or spectroscopically, this type of biosensor can be used as standalone point detector with audible and visual alarm capabilities. Biosensor detection will be easy to use, require no external power, and provide close to 100 percent accuracy (i.e., highly selective).

Biosensor techniques will likely be used to identify and confirm the presence of an agent after a less sensitive or specific CWA alarm has indicated the presence of agent. A presently fielded biosensor technology that uses electrochemistry to detect agent reacted with an agent specific enzyme is detector A21, the Jasmin Simtec Nerve Agent Immobilized-Enzyme Alarm and Detector (NAIAD).

Appendix A

Listed below are the detectors for which the manufacturer verified the non-italicized information. Information is listed in alphabetical order by manufacturer.

Point Detectors

1) Dycor Quadlink by Ametek
2) M 8 Paper by Anachemia Canada, Inc.
3) M 256A1 Kit by Anachemia Canada, Inc.
4) Nerve Agent Vapor Dector by Anachemia Canada, Inc.
5) C2 CAD Kit by Anachemia Canada, Inc.
6) Paper, Chemical Agent Liquid Detector, 3-Way by Anachemia Canada, Inc.
7) Chemical Agent Vapor Detector by Anachemia Canada, Inc.
8) IS-101 by HNU Systems, Inc.
9) M8A1/M43A1 by Intellitec
10) SAW MINICAD MK II by Microsensor Systems, Inc.
11) Drager-Tube Gas Detection System by National Drager, Inc.
12) Polytron Gas Detection System by National Drager, Inc.
13) Phemtochem Ion Mobility Spectrometer, Model 110 by PCP Inc.
14) MINIRAE Plus by RAE Systems
15) No. 1 Mark 1 Detector Kit, Chemical Agent Residual Vapor Detector (RVD) by Richmond Packaging (UK) Limited
16) No. 2 Mark 1 Water Test Kit, Poison by Richmond Packaging (UK) Limited
17) Chemical Agent Detection System II (CADS II) by Scientific Instruments Limited
18) M90 – D1 Chemical Warfare Agent Detector by Sensor Application, Inc.
19) Scentograph Plus II with AID/RCD Detector by Sentex Systems, Inc.
20) SCX-20 VOC Monitor by Spectrex Corporation

Stand Off Detector

1) Fourier Transform Spectrometer by Bomem, Inc.
2) M21 Remote Standoff Chemical Agent Alarm by Intellitec
3) AN/KAS-1A Chemical Warfare Directional Detector by Intellitec
4) Laser Remote Detector by Research Institute 070 BRNO

Analytical Instruments

1) Automatic Continuous Air Monitoring System (ACAMS) by ABB Process Analytical.
2) Cub 800 by Bear Instruments, Inc.
3) Trace Ultra High Detector by Bio Rad/Digi Labs
4) Raman Chemical Analyzer by Gamma Metrics
5) HP 5973 MSD by Hewlett-Packard, Co.
6) HP 2350 A Atomic Emission Detector by Hewlett-Packard, Co.
7) HP 6890 GC System by Hewlett-Packard, Co.
8) Mass Spectrometer Using Recently Patented Technology by Ionics, Inc.
9) API 365 by PE Sciex
10) Sentoscreen with AID by Sentex Systems Inc.
11) Dual Flame Photometric Detector by SRI Instruments
12) 3DQ by Teledyne Electronic Technologies
13) Saturn by Varian Chromatography Systems
14) Viking Spectra Track 572 by Viking Instruments Corp.

Appendix B

The detectors included in this survey are a representative sample of the technologies discussed in Volume I. Several of the detectors initially identified were not included in the survey because they are no longer produced or insufficient information existed. These detectors are listed below by the section were they had been found

Point Detectors

1) Ultrasonic Concentration Meter – ultrasonic viscosity meter by JM Science Inc.
2) Portable Agent Detector (PAD) by Nuclear Research Corporation
3) Photovac Model 10S Plus Portable Gas Chromatograph by Photovac International Inc.
4) Ion Mobility Sensor (IMS) by Westinghouse Science and Technology Center
5) US Navy Chemical Agent Point Detection System (CAPDS MD 21 mod 1) by Nuclear Research Corporation
6) Field Ion Spectrometer (FIS) by Mine Safety Appliances
7) FMK 9002 Continuous Hazardous Gas Monitoring System by MST Measurement Systems, Inc.
8) MD-16 Continuous Mini Gas Detector by CEA Instruments, Inc.
9) Polytron Gas Detection Systems by National Drager, Inc.
10) Ultima Gas Monitor by Mine Safety Appliances
11) Model CGM 929A by Dynamation Inc.
12) 580 EZ by Thermo-Enviromental Instruments, Inc.
13) XM 22 Automatic Chemical Agent Alarm (ACADA), experimental replaced by GID-3
14) CAA/2 by Microsensor Systems, Inc., does not exist
15) Pace Environmental's Detector by Pace Enviromental, does not exist
16) Process Spectropusto-Meter (Pro-Spec) by UOP Guided Wave Process Analytical Systems, does not detect CWAs
17) Mustard Module by Honeywell Elac
18) U.K. Chemical Agent Monitor (CAM), by Graseby Ionics

Standoff Detectors

1) Chemical Agent Alarm System by Validyne Engineering Corp.
2) Detadis remote Laser Sensor of Chemical War Agents by Cilas

Analytical Instruments

1) Raman Imaging Microscope by Renishaw
2) P200 Micro Gas Analyzer by MTI Analytical Instruments
3) Capillary Ion Analyzer by Waters Chromatography Div./Millipore Corp.

APPENDIX D: Chemical Warfare Agent Laboratories

There are a number of commercial and government laboratories that are certified to work with Chemical Warfare Agents (CWAs). These laboratories would be used when there is a need to analyze samples of soil, water and vegetation that are suspected to be contaminated with CWAs. Certified CWA laboratories use CWA standards in order to quantify their analysis. CWA standards are essential for insuring that results from one laboratory can be compared to the results of another laboratory. The U.S. Army has a quality assurance program for the preparation, analysis, storage, and use of chemical agent standards. This program is called the Chemical Agent Standard Analytical Reference Material (CASARM) Program. The CASARM program is managed by the Soldier and Chemical, Biological Defense Command which also certifies the CWA laboratories. The list of the CWA certified laboratories follows:

Commercial Neat Laboratories:

Battelle
505 King Avenue
Columbus, OH 43201
Phone: (614) 424-5390
FAX: (614) 424-4905
POC: Harry Hawkins

Calspan SRL Corporation
P.O. Box 400
Buffalo, NY 14225
Phone: (716) 632-7500
FAX: (716) 631-4183
POC: Michael Moskal

Geomet Technologies, Inc.
8577 Atlas Drive
Gaithersburg, MD 20877
Phone: (301) 417-9605
FAX: (301) 990-1925
POC: Mr. Frank Kelly

IIT Research Institute
10 West 35th Street
Chicago, IL 60610
Phone: (312) 567-4262
FAX: (312) 567-4286
POC: Dr. Rajan

Midwest Research Institute
425 Volker Boulevard
Kansas City, MO 64110
Phone: (816) 753-7600
FAX: (816) 754-8420
POC: Chris Bailey

Southern Research Institute
2000 Ninth Avenue South
P.O. Box 55305
Birmingham, AL 35255-5305
Phone: (205) 581-2219
FAX: (205) 581-2726
POC: Dr. Ralph Spafford

APPENDIX D: Chemical Warfare Agent Laboratories

Commercial RDTE Solution (diluted agent) Laboratories:

Southwest Research Institute
6220 Culebra Road, P.O. Box 28510
San Antonio, TX 78228-0510
Phone: (210) 522-5168
FAX: (210) 522-3649
POC: Joseph Brewer

Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439-4832
Phone: (630) 252-9873
FAX: (630) 252-6407
POC: Dr. Hugh J. O'Neill

Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, WA 99352
Phone: (509) 375-6318
FAX: (509) 375-3649
POC: Dr. Earl Morgan

CMS Field Products Group
200 Chase Park South
Suite 101
Birmingham, Alabama 35244
Phone: (205) 733-6900
FAX: (205) 733-6919
POC: Sandra Macon

QuickSilver Analytics, Inc.
2012 Tollgate Road, Suite 201
Bel Air, MD 21015
Phone: (410) 569-5900
FAX: (410) 569-8008
POC: Rodney D. Hudson

Commercial Small Quantity Neat Laboratories:

Environmental Technologies Group, Inc.
1400 Taylor Avenue, P.O. Box 9840
Baltimore, MD 21284-9840
Phone: (410) 321-5200
FAX: (410) 321-5255
POC: John Schmidt

Truetech, Inc.
680 Elton Avenue
Riverhead, NY 11901
Phone: (516) 727-8600
FAX: (516) 727-7592
POC: Daniel Kohn

APPENDIX D: Chemical Warfare Agent Laboratories

Army Chemical Agent Monitoring Laboratories:

Anniston Chemical Activity
ATTN: SCBAN-CMO
POC: Bob Phillips
Phone: (205) 235-7241
Anniston, AL 36201

Blue Grass Chemical Activity
ATTN: SCBBG-CLD
POC: Tom Hancock
Phone: (606) 625-6347
Richmond, KY 40475

Deseret Chemical Depot
ATTN: SCBTO-CHO
POC: Tracy Dauwalder
Phone: (801) 833-4236
Tooele, UT 84074-5031

Edgewood Chemical Activity
ATTN: SCBRD-ODC
POC: Tim Blades
Phone: (410) 671-4676
Aberdeen Proving Grnd, MD 21010-5423

Newport Chemical Depot
ATTN: SCBNE-PA
POC: Jenny Stockman
Phone: (317) 245-4400
Newport, IN 47966

Pine Bluff Chemical Activity
ATTN: SCBPB-CRL
POC: Dr. Ronald Wise
Phone: (870) 540-3291
Pine Bluff, AR 71602-9500

Pueblo Chemical Depot
ATTN: SDSTE-PU-CSUR
POC: Debbie Strait
Phone: (719) 549-4170
Pueblo, CO 81001-5000

Umatilla Chemical Depot
ATTN: SCBUL-L
POC: Phil Ferguson
Phone: (541) 564-5235
Hermiston, OR 97838

APPENDIX E

POLICY PAPER

CSEPP Policy Paper Number 2

ENVIRONMENTAL SAMPLING TO DETERMINE CHEMICAL AGENT CONTAMINATION

This document establishes the Chemical Stockpile Emergency Preparedness Program (CSEPP) policy on environmental monitoring and sampling in the event lethal chemical agents are released to the environment.

In the event of a release involving the stockpile of unitary chemical weapons, the Army's Initial Response Force Commander (IRFC) or Service Response Force Commander (SFRC) also serves as the Federal On-Scene Coordinator (OSC) under the National Contingency Plan (NCP):

> “(b) For releases of hazardous substances, pollutants, or contaminants, when the release is on, or the sole source of the release is from, any facility or vessel, including vessels bareboat-chartered and operated, under the jurisdiction, custody, or control of [Department of Defense] DOD… DOD shall provide OSCs/[Remedial Program Managers] RPMs responsible for taking all response actions...” (40 CFR 300.120)

The health and safety of the personnel engaged in sampling activities is a primary concern and explicitly identified in the NCP as being subject to the Hazardous Waste Operations and Emergency Response Regulations (HAZWOPER) as promulgated by the Occupational Safety and Health Administration in 29 CFR 1910.120.

> “4(b)(1) All governmental agencies and private employers are directly responsible for the health and safety of their own employees.” (40 CFR 300.150)

> “(a) Response actions kinder the NCP will comply with the provisions for response action worker safety and health in 29 CFR 1910.120.” (40 CYR 300.150)

A safe and professional sampling program requires experienced .personnel, rigorous and frequent training, adequate funding, and a stringent equipment maintenance program. The Army has sampling teams located at the installations which store chemical agents. The Army, as the On-Scene Coordinator, will be responsible for sampling soil, air, and water to check for contamination by chemical agents.

State and/or local personnel may accompany Army sampling and monitoring teams under the condition that they are properly trained, qualified, and equipped in accordance with the regulations governing Hazardous Waste Operations and Emergency Response. Additionally, State and/or local personnel observing or accompanying the Amy sampling teams must be fully trained and certified by the Army in chemical agent awareness and Army chemical agent sampling procedures.

These activities will use State and/or local personnel who are already trained in accordance with HAZWOPER requirements. CSEPP will not fund HAZWOPER training solely for offpost responders to accompany Army sampling teams.

Michael W. Owen	Craig S. Wingo
Acting Assistant Secretary of the Army (Installation, Logistics, and Environnent)	Assistant Associate Director Office of Technological Hazards FEMA
9/30/93	10/5/93
Date	Date

APPENDIX F
Listing of Source Documents

NAME	PUBLISHER	DATE
Handbook of Atmospheric Diffusion	Hanna, Briggs, Hosker	1982
Sampling Quality Assurance User's Guide (EPA 600/8-89/046)	Environmental Research Center, University of Nevada, Las Vegas	Mar-89
Health Effects of Warfare Agent Exposure (The Environmental Professional, Vol. 11, pp 335-353)	National Association of Environmental Professionals	1989
Emergency Response Branch Region VIII Quality Assurance Project Plan	US EPA, Region VIII, Ecology & Environment, Inc.	Jan-90
Reentry Planning: The Technical Basis for Offsite Recovery Following Warfare Agent Contamination (ORNL 6628)	Oak Ridge National Laboratory, A. P. Watson, N.B. Munro	Apr-90
DRAFT Results of a workshop meeting to discuss Protection of Public Health and Safety during Reentry into Areas Potentially Contaminated with a Lethal Chemical (GB, VX, or Mustard agent).	Center for Disease Control, Health & Human Service, Public Health Service	Jul-90
Unitary Agents: A Roadmap to Control Limits and Analytical Methods	US AEHA, Stephen Kistner	Jun-92
Protocol for Determination of Chemical Warfare Agent Simulant Movement through Porous media	ORNL/TM-12002, A. P. Watson et al	Jul-92
Characterizing biological variability in livestock, blood, cholinesterase activity for bio-monitoring organophosphate nerve agent exposure	Journal of the American Veterinary medical Association, Vol. 201, No 5, pages 714-725	Sep-92
Relative Potency Estimates of Acceptable Residues after Nerve Agent Release (Ecotoxicology & Environmental Safety 23, 328-342)	Oak Ridge National Laboratories,	1992
Introduction to Type, fifth edition	Isabell Briggs Meyers	1993
The Team Performance Model	Drexler, Sibbett & Forester, from NTL	1993
Environmental Sample Design: Research Facilitating Reentry/Restoration Decisions after Chemical Warfare Agent Release	ORNL	Mar-94
Mini-Library: CSEPP Reentry/Restoration Resource Material	Reentry/Restoration Subcommittee of the CSEPP Joint Steering Committee, Stephen Kistner, Chair	Jul-94
Evaluation of NCEH Decision Logic for PPE Recommendations for Civilian Emergency Workers Following a Chemical Agent Release; and cover letters	Laborers Health & Safety Fund of North America, John Moran	Sep-94
29 CFR 1910 et al Respiratory Protection, proposed rule	Federal Register	Nov-94
Colorado CSEP Recovery Tabletop Exercise	Colorado CSEPP	Nov-94

APPENDIX F
CSEPP OFF POST MONITORING LIBRARY

NAME	PUBLISHER	DATE
Rapid Method for Isolating Targeted Organic Compounds from Biological matrices	Oak Ridge National Lab	1994
Protocol, RCRA Part B Permit; Risk Assessment No. 39-26-1401-95; Pine Bluff Chemical Agent Disposal Facility	US Army PM Chem DeMil	Jun-95
Comments on CDC Recommendation for Civilian Communities Near Chemical Weapons Depots; Guidelines for Medical Preparedness (Federal Register 38191, 7/27/94)	US Department of Labor, OSHA	Jul-95
Draft Concept Plan for Off-Post Monitoring	Deseret Chemical Activity	Jul-95
Worldwide Chemical Detection Equipment Handbook	Defense Technical Information Center	Oct-95
Rules of the Road: A Guide for Leading Successful IPTs	Department of Defense, Undersecretary of Defense for Acquisition & Technology	Nov-95
DRAFT Agency Monitoring Requirements (DA PAM 385-61)	Department of the Army	1995
Market Survey of Low-Level Chemical Safety Monitors for Application at US Chemical Weapons Storage Sites, Program Review Briefing	Battelle for CBDCOM	Mar-96
SAW Minicam Mk II User's Guide	Microsensor Systems Inc.	May-96
Some thoughts on the Use of Low Level Sampling during Emergency Response Operations	Mike Williams, Anniston CSEPP	May-96
Letter to Cheri Foust: Interpretation of OSHA Respiratory Wok Rules	US Department of Labor, OSHA	Jun-96
Newport (IN) Exercise Sampling Plan	CSEPP	Jun-96
Letter to Oregon Emergency Management: Commitment to Perform Off-Post Monitoring	Umatilla Depot Activity	Jul-96
Memorandum: Interim Chronic Toxiclogical Criteria or Chemical Weapons Councils	Department of the Army	Aug-96
Web Page, FEMA CSEPP	FEMA	Aug-96
Guidelines for Developing Emergency Exposure Levels for Hazardous substances	Committee on Toxicology, National Research Council	Nov-96
Recovery Plan for the Deseret Chemical Depot: Tooele, Utah	US Army Chemical and Biological Defense Command	Nov-96
Scenario-based off-post monitoring plan	CSEPP	Nov-96
Statement of Work: Argonne Lab Support for Off-Post Monitoring IPT	CSEPP	Nov-96
Toelle County Emergency Operations Plan, Recovery for Chemical Events at Deseret Chemical Depot (Appendix 1 to Annex R)	Tooele County, UT	Nov-96

APPENDIX F
CSEPP OFF POST MONITORING LIBRARY

NAME	PUBLISHER	DATE
Utah Chemical Stockpile Emergency Preparedness Program CSEPP Appendices to state Emergency Operations Plan, Section 13.0, Recovery	State of Utah	Nov-96
Utah County Reentry and restoration Plan	Utah County, UT	Nov-96
DRAFT: Information Sheet to Aid in the Understanding of the Importance of he Concept of Operations and Work Rules	? ?	Dec-96
Letter: Umatilla Mitigation Agreement	Morrow Co.(OR) & CSEPP (OR)	Dec-96
Briefing Slides: Development of Toxicological Standards for Chemical Agents	USA CHPPM	1996
Excerpt from exercise report, Umatilla, regarding off post monitoring, page b-2	CSEPP	1996
Interpretation of OSHA Work rules	ORNL	Jan-97
Umatilla Detector Study: Analysis of the Expected Effectiveness of Detectors at Responder Locations, Volumes I, II, III	Innovative Emergency Management for CSEPP	Jan-97
Off-Post Monitoring IPT Detector Matrix	CSEPP: Rob	Feb-97
Briefing materials: ACGIH Recommended Exposures for Unprotected Chemical Agent Workers	LTC Rick Kramp	Mar-97
Briefing materials: Health & Medical preparedness	KY CSEPP	Mar-97
Briefing materials: Technical Planning and Resolution Meeting, Health & Medical preparedness	KY CSEPP	Mar-97
Briefing slide set: Kentucky briefing on determination of areas at Risk during a chemical release: Hazmat & CSEPP	CSEPP	Mar-97
Briefing slide set: Kentucky briefing on Low Level Real Time Detection for Response Worker Protection and Plume tracking	CSEPP	Mar-97
Colorado CSEPP Team Integrated emergency Recovery Management Plan (DRAFT Revision 4)	Colorado CSEPP	Mar-97
DRAFT REPORT: Evaluation of Airborne Exposure Limits for G-Agents: Occupational and General Population Exposure Criteria	Toxicology Team, US Army Research, Development and Engineering Center	Mar-97
Glossary of Terms	Rick Kramp, for KY CSEPP	Mar-97
Utility of Off-Post Decontamination of Personnel in a CSEPP Event	LTC Richard Kramp, CBDCOM & the Centers for Disease Control	Mar-97
An innovative Strategy for Monitoring Downwind Contamination during Emergencies involving the Release of Hazardous Materials	URS Operating Services, William J. Fodor	Apr-97
Colorado CSEPP Recovery Objective	Colorado CSEPP	Apr-97
List of Army-certified surety labs	Tom Ball (UT)	May-97
Real Time Analytical Platform	CSEPP: Kevin Kammerer	May-97

APPENDIX F
CSEPP OFF POST MONITORING LIBRARY

NAME	PUBLISHER	DATE
Statement to the National Research Council by US Senator Ron Wyden (OR) regarding Emergency Preparedness Issues at the Umatilla Weapons Depot.	Office of Senator Wyden	May-97
CDC Recommendations or Civilian Communities Near Chemical Weapons Depots: Guidelines for Medical Preparedness	US Department of Health & Human Services, Federal Register	Jun-97
29 CFR 1910.120 appendix D: Hazardous Waste Operations and Emergency Response	US Department of Labor, OSHA	(undated)
Article: Intrinsic Safety and Gas Environments	Industrial Scientific Group, David Kulawa	(undated)
Comprehensive Monitoring Plan for Washington State CSEPP Program	Washington State Department of Emergency Management	(undated)
Memorandum of Agreement or Monitoring, Traffic Control, and Decontamination Support between Tooele Chemical Activity and Tooele County (UT)	Tooele Chemical Activity and Tooele County (UT)	(undated)
Presentation Slides: Air Monitoring	Umatilla Chemical Depot, Laboratory Support Division, Philip Ferguson	(undated)
Us EPA Response to Team Center Response Engineering Analytical Contract: Air Sampling, Monitoring, Analytical and Modeling Capabilities	US EPA	(undated)

Appendix G

Off-Post Monitoring Integrated Product Team Members:

Name	Position	Telephone	Facsimile
Rick Kammerer	FEMA Region X	(425) 487-4755	(425) 487-4777
Jan Glarum	Oregon Health Department EMS	(503) 731-4011 ext. 650	(503) 731-4077
Mike Williams	Anniston Chemical Depot	(205) 235-4940	(205) 235-4630
Doug Davis	Pueblo Chemical Depot	(719) 549-4364	(719) 549-4375
Bill Burger	Kentucky Environmental Protection	(502) 564-2150 ext. 150	(502) 564-2741
Jim Featherston	Jefferson County AR EMS	(870) 541-5470	(870) 541-5477
Dan Feighert	HQ FEMA	(202) 646-3250	(202) 646-4321
Rob Weiss	U.S. Army CSEPP	(410) 612-8791	(410) 671-3179
Frank Blechman	Facilitation Advisors Bureau	703-356-9797	(703) 993-1302
Paul Roberts	Argonne National Laboratory	(202) 488-2407	(202) 488-2413
Kevin Kammerer	U.S Army CSEPP	(410) 612-7666	(410) 671-3179

APPENDIX H: Chemical Warfare Agent Toxicities

Table 1: Chemical Warfare Agent Dosages of Significance[1]

milligram-minutes per cubic meter (mg-min/m^3)

DOSAGE	CHEMICAL WARFARE AGENT		
	H, HD, HT	GB	VX
1% LETHALITY[2]	150	10	4.3
NO DEATHS[3]	100	6	2.5
No significant effects[4]	2.0	0.5	0.4

[1] Whitacre, C. Glenvil, et al, Personal Computer Program for Chemical Hazard Prediction (D2PC), CRDEC-TR-87021 (January 1987).
[2] U.S. Department of the Army. *Toxic Chemical Agent Safety Standards*, DA Pamphlet 385-61. Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (March 31, 1997).
[3] U.S. Army Center for Health Promotion and Preventive Medicine Technical Guide 218, Detailed and General Facts About Chemical Agents (October 1996).
[4] Thacker, Stephen B., M.D., M.Sc., Assistant Surgeon General, Acting Director, National Center for Environmental Health, Centers for Disease Control and Prevention DHHS, letter to Colonel James M. Coverstone, Deputy for Chemical Demilitarization, Office of the Assistant Secretary of the Army *Recommended Acute Threshold Effects Levels for CSEPP Program* (June 24, 1994).

APPENDIX H: Chemical Warfare Agent Toxicities

Table 2: Chemical Warfare Agent Concentrations of Significance[5]

milligrams per cubic meter (mg/m^3)

CONCENTRATION	CHEMICAL WARFARE AGENT		
	H, HD, HT	GB	VX
Immediately Dangerous to Life or Health (IDLH)	NA[6]	0.2	0.02
Unmasked Agent Worker 8-hour Time Weighted Average (TWA)	0.003	0.0001	0.00001
Non-Agent Worker and General Population 72-hour TWA	0.0001	0.000003	0.000003
Ceiling Value[7]	0.003	0.0001	0.00001

Note: For additional information, please refer to *Compilation of Existing Chemical Agent Guidelines as of September 1997* by Cheri Bandy Foust, Energy Division,Oak Ridge National Laboratory (September 1997).

[5] U.S. Department of the Army. *The Army Chemical Agent Safety Program*, Army Regulation 385-61. Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (February 28, 1997).

[6] Since IDLH values are used solely for the purpose of establishing the concentrations at which SCBA or supplied-air respirators are required, it is not necessary to formally establish IDLH values for H, since workers will already be required to wear these types of respiratory protection at concentrations much lower than what is considered IDLH for H, due to concerns over carcinogenicity.

[7] Ceiling value normally refers to the maximum exposure concentration at any one time, for any duration. Practically, it is the average value over the minimum time to determine a specified concentration.